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Katsura et al.

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(45) **Date of Patent: Dec. 1, 2015**

(54) **PAPER CONVEYING DEVICE, IMAGE FORMING APPARATUS PROVIDED WITH THE DEVICE AND PAPER CONVEYING METHOD**

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PCT Pub. Date: **Sep. 26, 2013**

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B65H 7/20 (2006.01)
B65H 9/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC .. ***B65H 7/20*** (2013.01); ***B65H 3/44*** (2013.01); ***B65H 5/068*** (2013.01); ***B65H 5/26*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC B65H 9/006; B65H 3/06; B65H 5/06; B65H 5/062; B65H 2301/331; B65H 2511/11; B65H 2551/10
USPC 271/242
See application file for complete search history.

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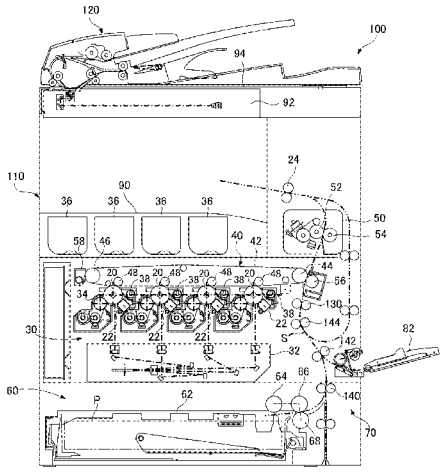
Primary Examiner — David H Bollinger
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

A paper conveying device includes: a registration roller pair provided along a paper conveying path; a pick-up roller, a paper feed roller and a separation roller for feeding sheets of paper to the paper conveying path; and a controller controlling conveyance of sheets of paper such that when a preceding sheet is stopped at the registration roller pair, a following, succeeding sheet is temporarily stopped at a prescribed position G downstream of a conveying roller in the paper conveying direction, and the succeeding sheet is re-conveyed toward the registration roller pair at a prescribed timing. The controller changes the timing to start re-conveyance of the succeeding sheet in accordance with paper length of the conveyed sheet of paper.

19 Claims, 18 Drawing Sheets



(51) **Int. Cl.**

B65H 7/02	(2006.01)
B65H 3/44	(2006.01)
B65H 5/26	(2006.01)
G03G 15/00	(2006.01)
B65H 5/06	(2006.01)
B65H 7/08	(2006.01)

(52) **U.S. Cl.**

CPC .. ***B65H 7/02*** (2013.01); ***B65H 7/08*** (2013.01); ***B65H 9/002*** (2013.01); ***B65H 9/006*** (2013.01); ***G03G 15/6564*** (2013.01); *B65H 2511/10* (2013.01); *B65H 2511/11* (2013.01); *B65H 2511/20* (2013.01); *B65H 2511/22* (2013.01); *B65H 2513/50* (2013.01); *B65H 2553/61* (2013.01); *B65H 2801/06* (2013.01)

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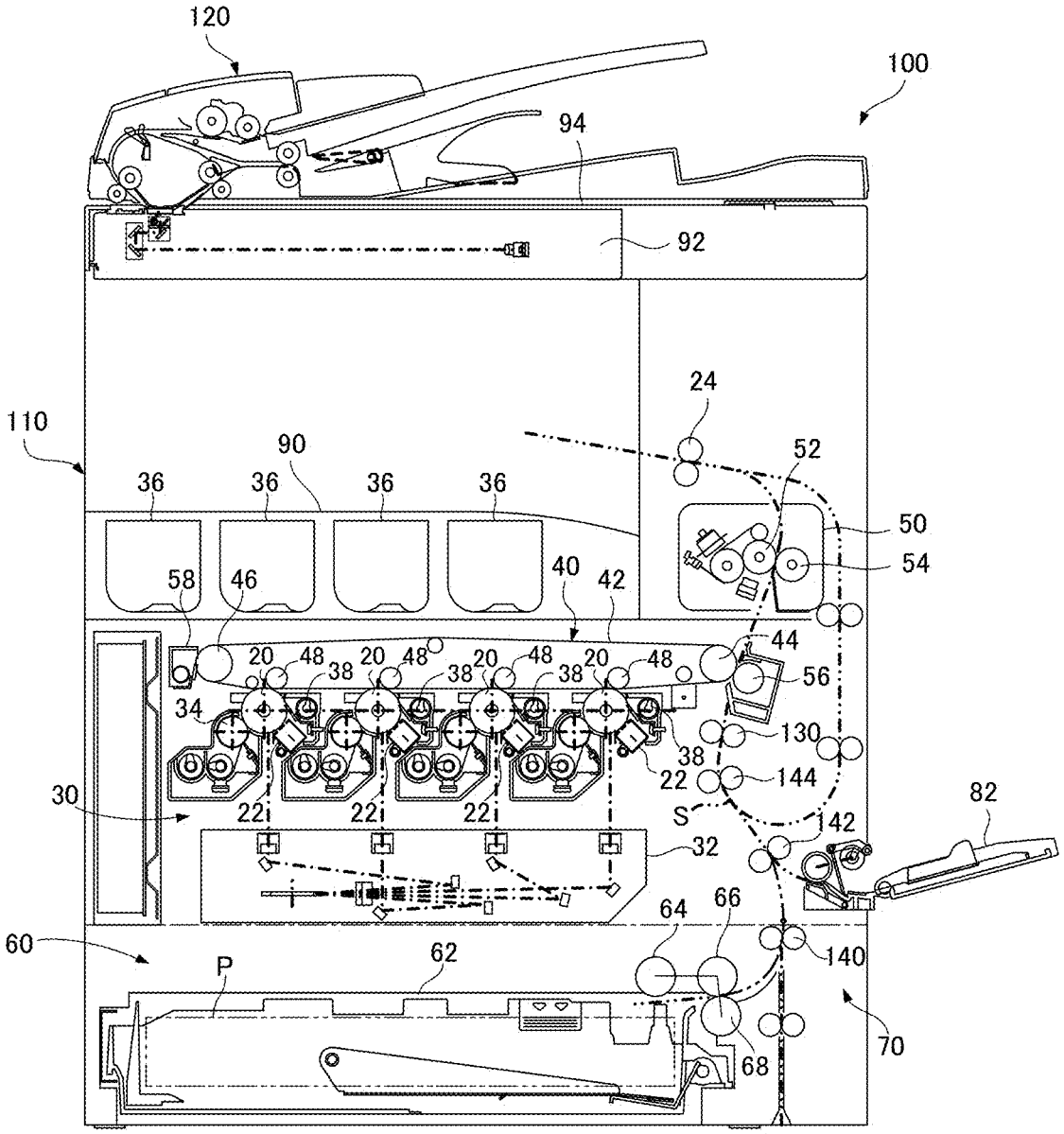
FIG. 1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92
24
110
90
52
36
36
36
36
50
54
58
46
40
42
44
20
48
38
56
34
130
38
22
144
30
S
142
82
32
64
66
60
P
62
140
70
68

FIG. 2

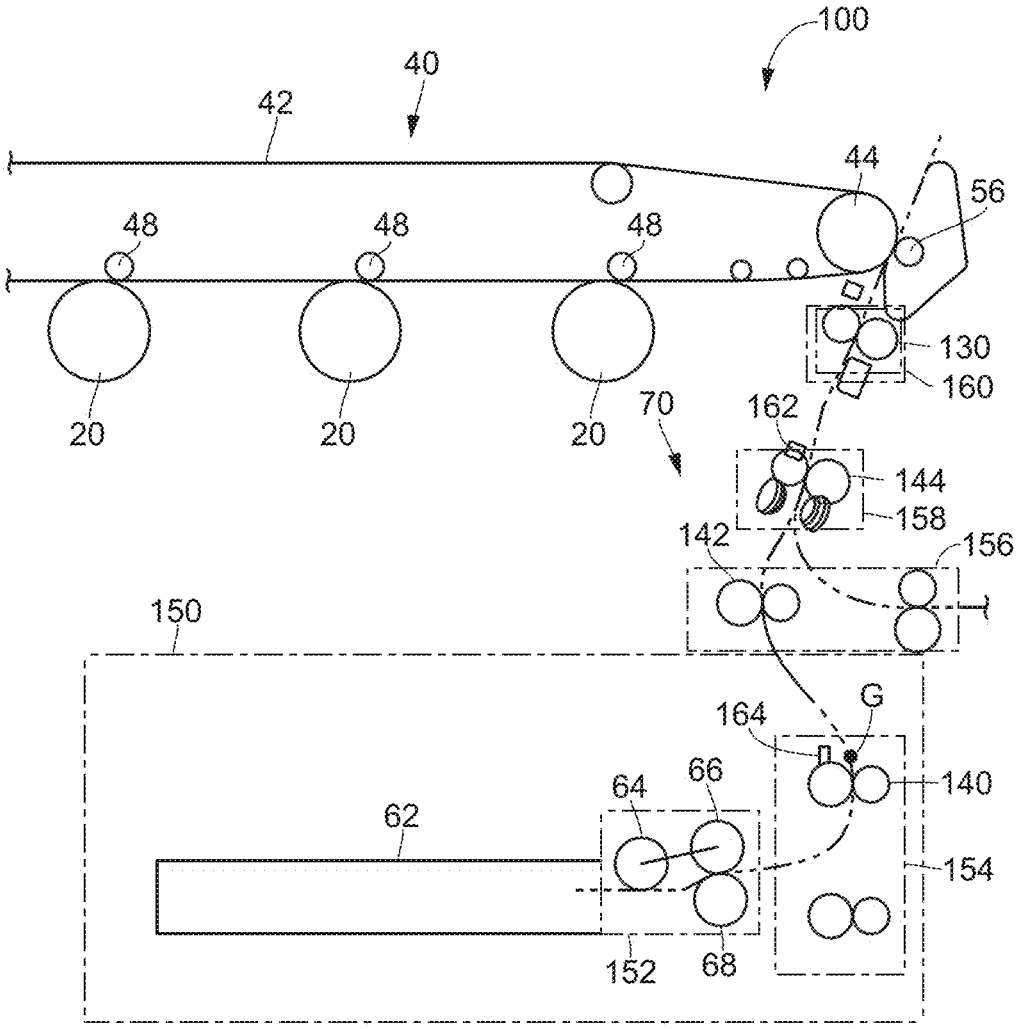

100
40
42
44
56
48
48
48
130
160
20
20
20
70
162
144
158
142
156
150
G
164
66
64
140
62
154
152
68

FIG. 3

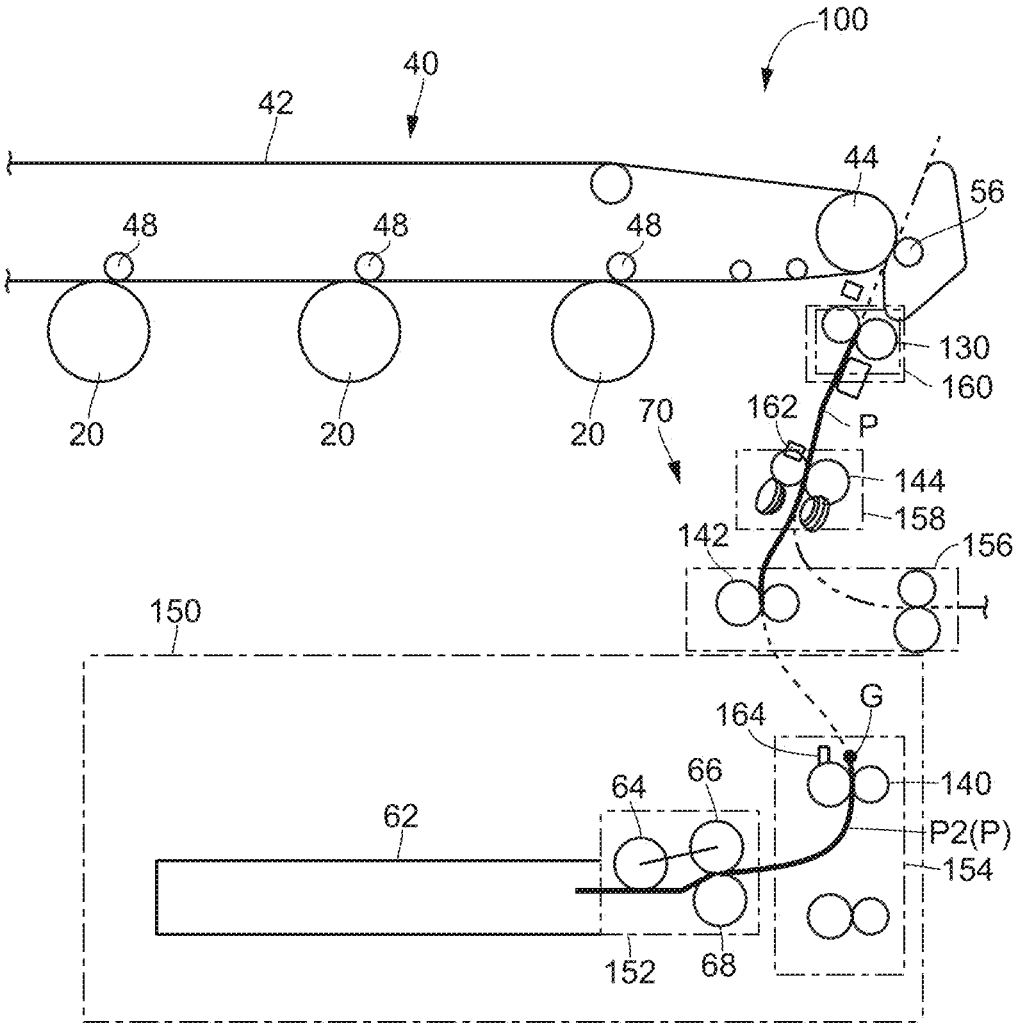

100
40
42
44
56
48
48
48
130
160
20
20
20
70
162
P
144
158
142
156
150
G
164
66
64
140
62
P2(P)
154
152
68

FIG. 4

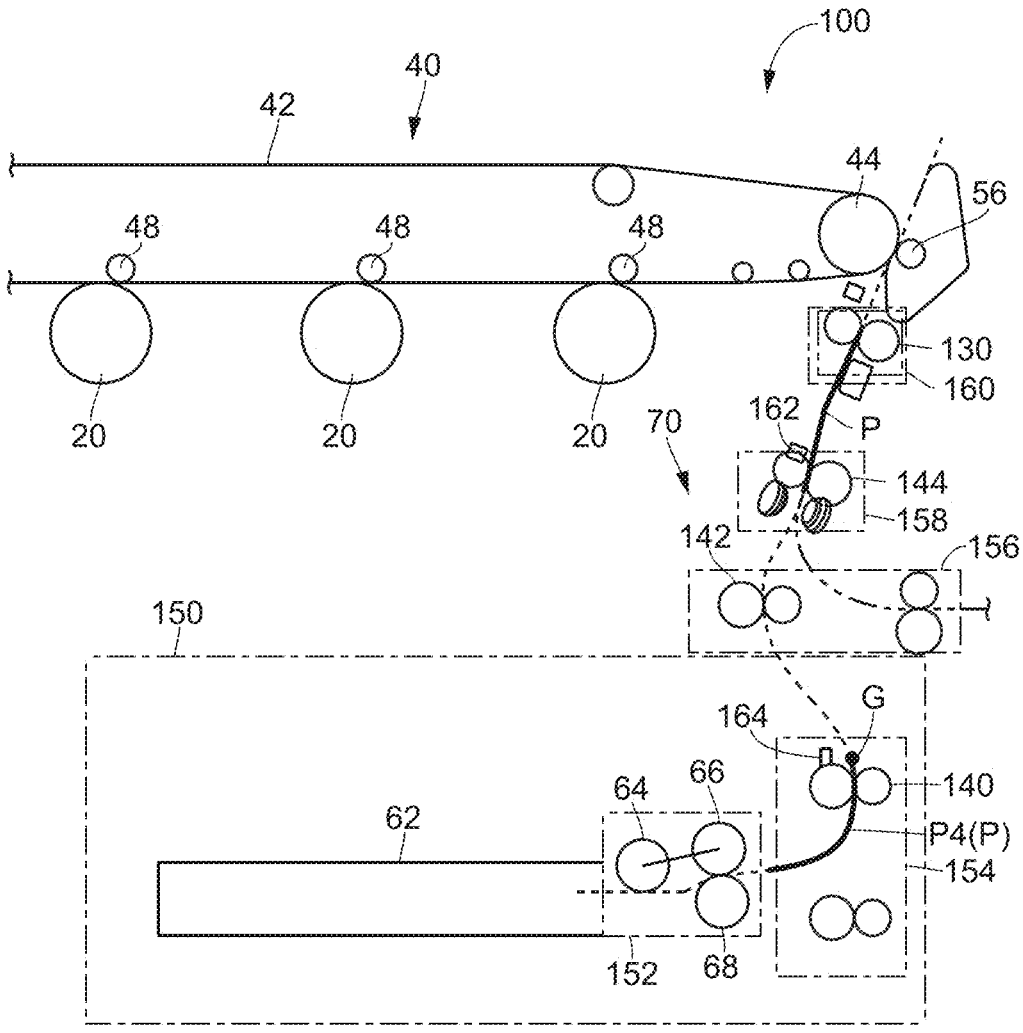

100
40
42
44
56
48
48
48
130
160
20
20
20
70
162
P
144
158
142
156
150
G
164
64
66
140
62
P4(P)
154
152
68

FIG. 5

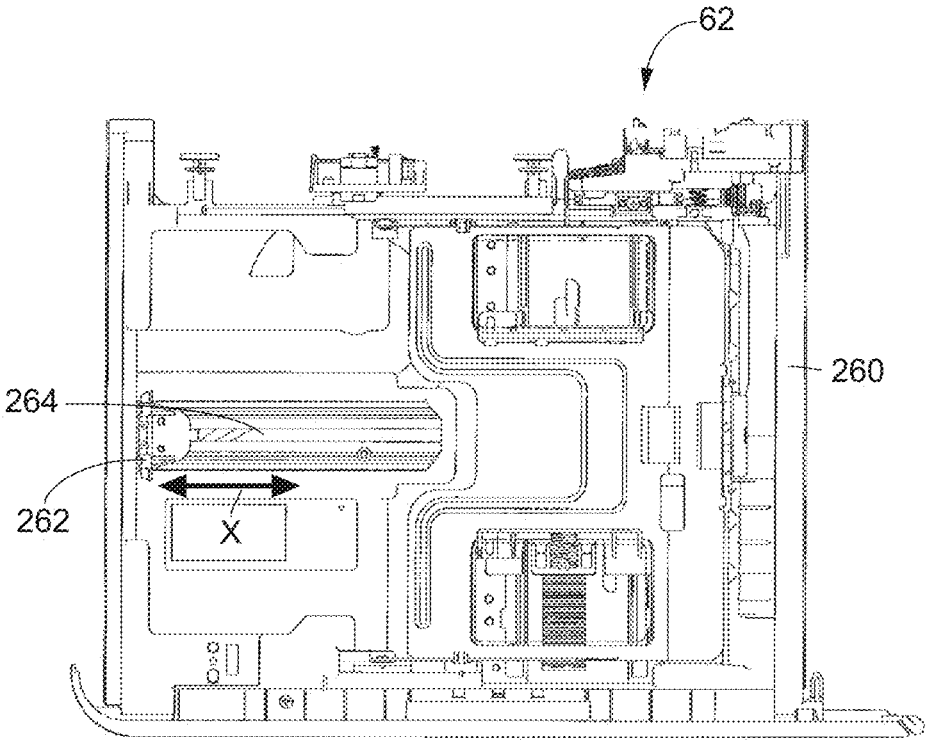


FIG. 6

FIG. 6A

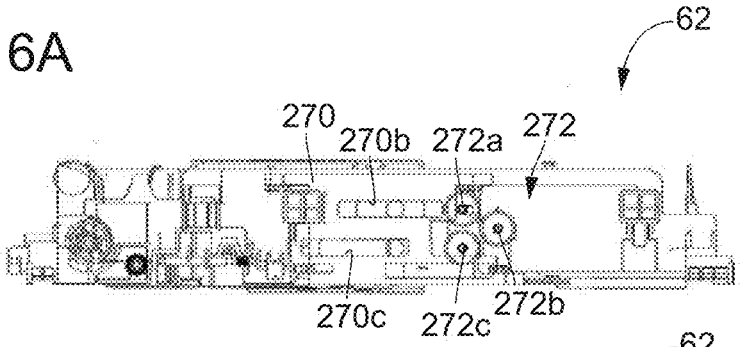


FIG. 6B

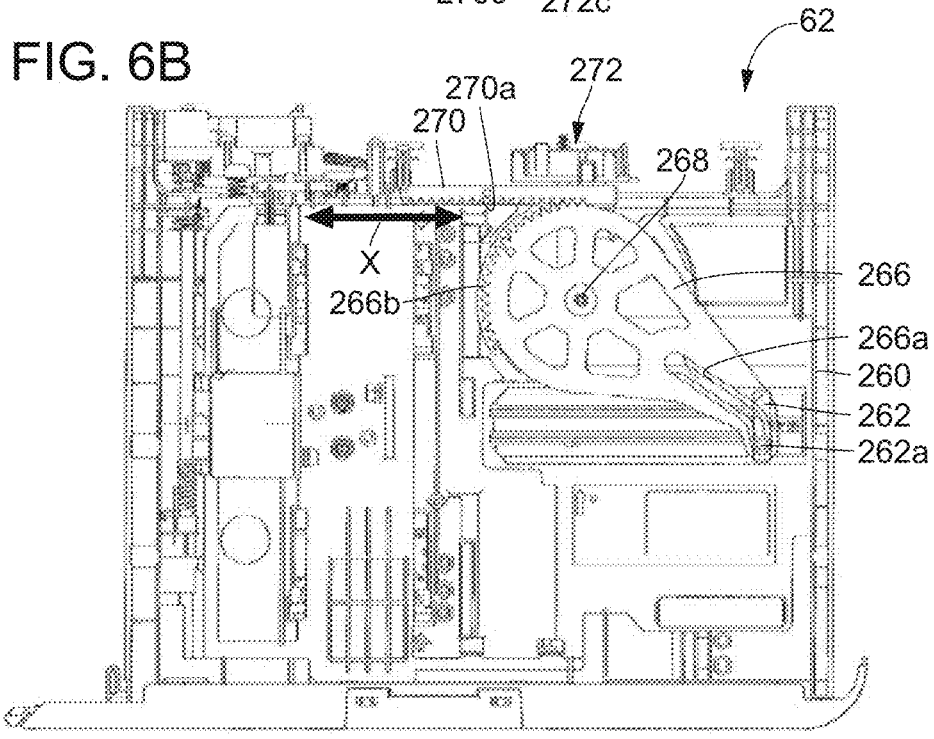


FIG. 7

FIG. 7A

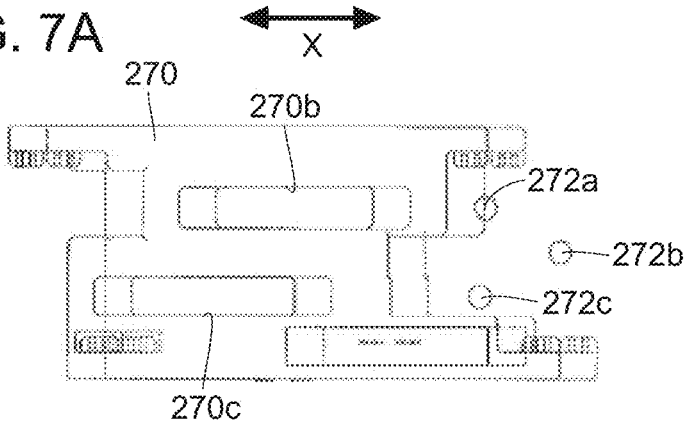


FIG. 7B

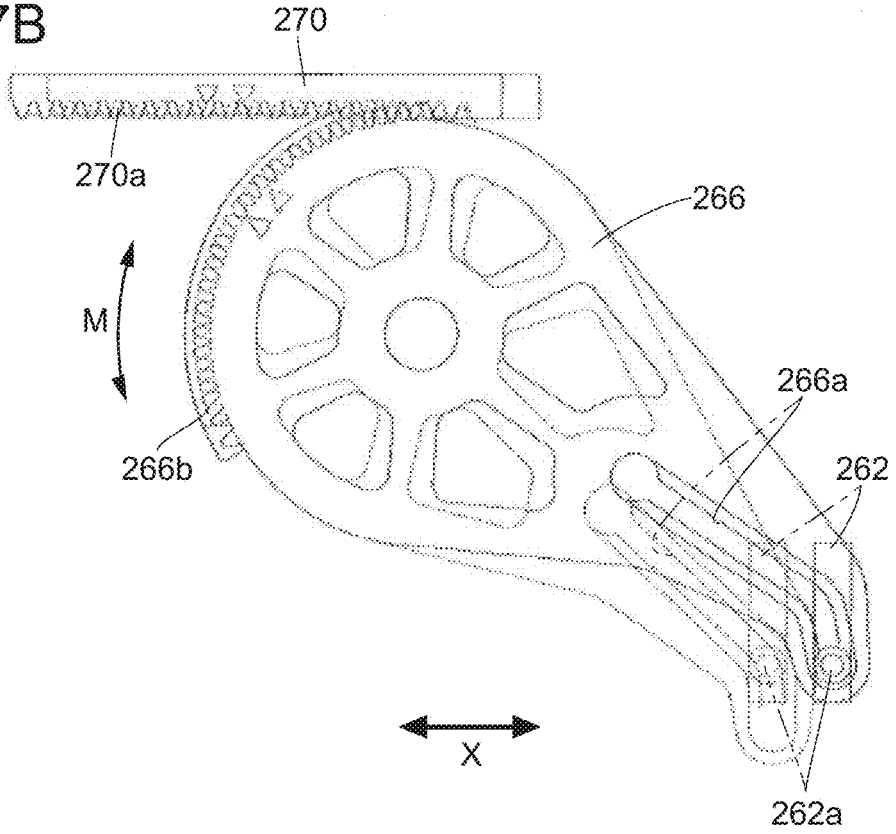


FIG. 8

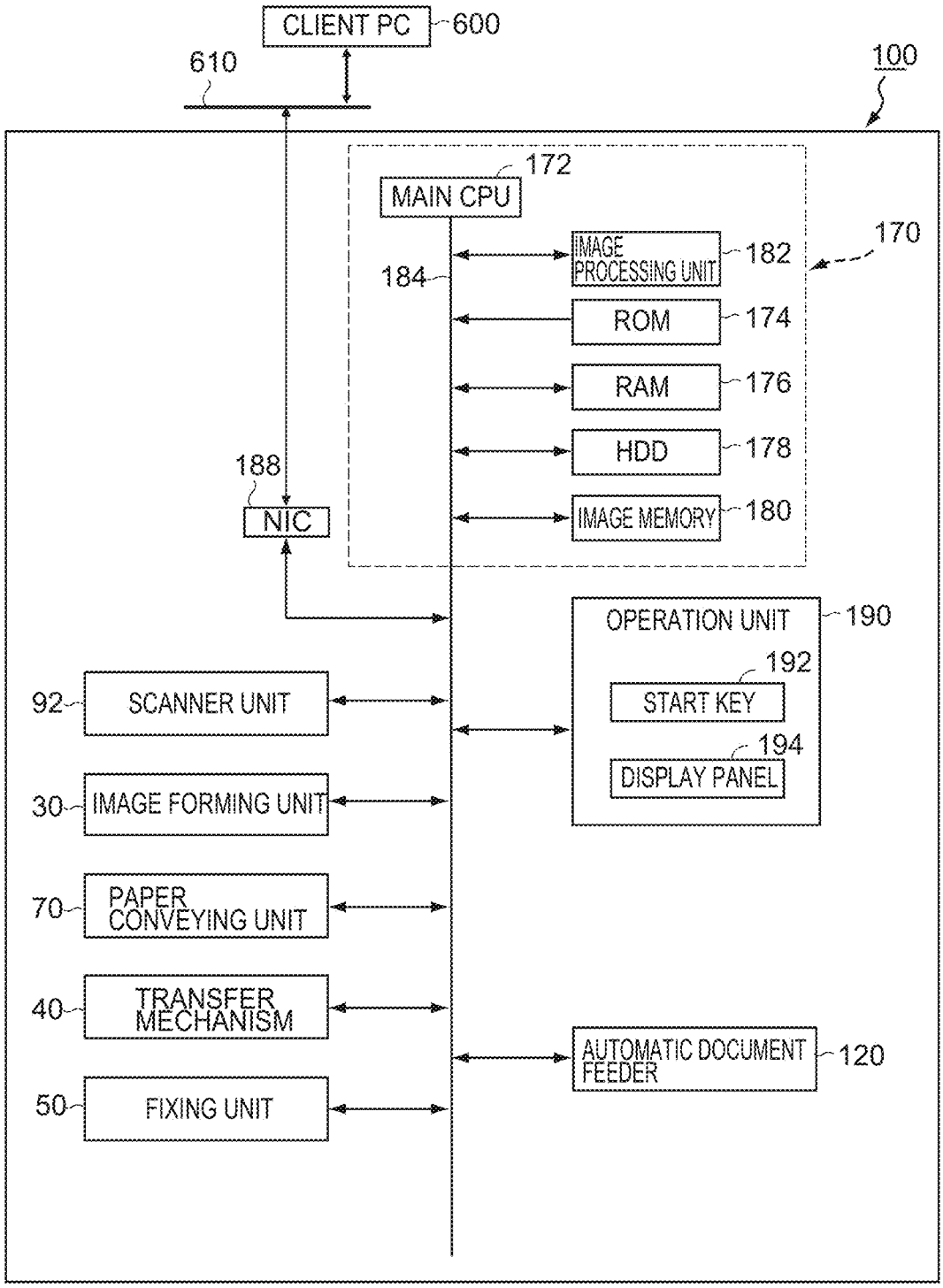

CLIENT PC
600
610
100
172
MAIN CPU
170
184
IMAGE PROCESSING UNIT
182
ROM
174
RAM
176
HDD
178
IMAGE MEMORY
180
188
NIC
OPERATION UNIT
190
192
START KEY
194
DISPLAY PANEL
92
SCANNER UNIT
30
IMAGE FORMING UNIT
70
PAPER CONVEYING UNIT
40
TRANSFER MECHANISM
50
FIXING UNIT
AUTOMATIC DOCUMENT FEEDER
120

FIG. 9

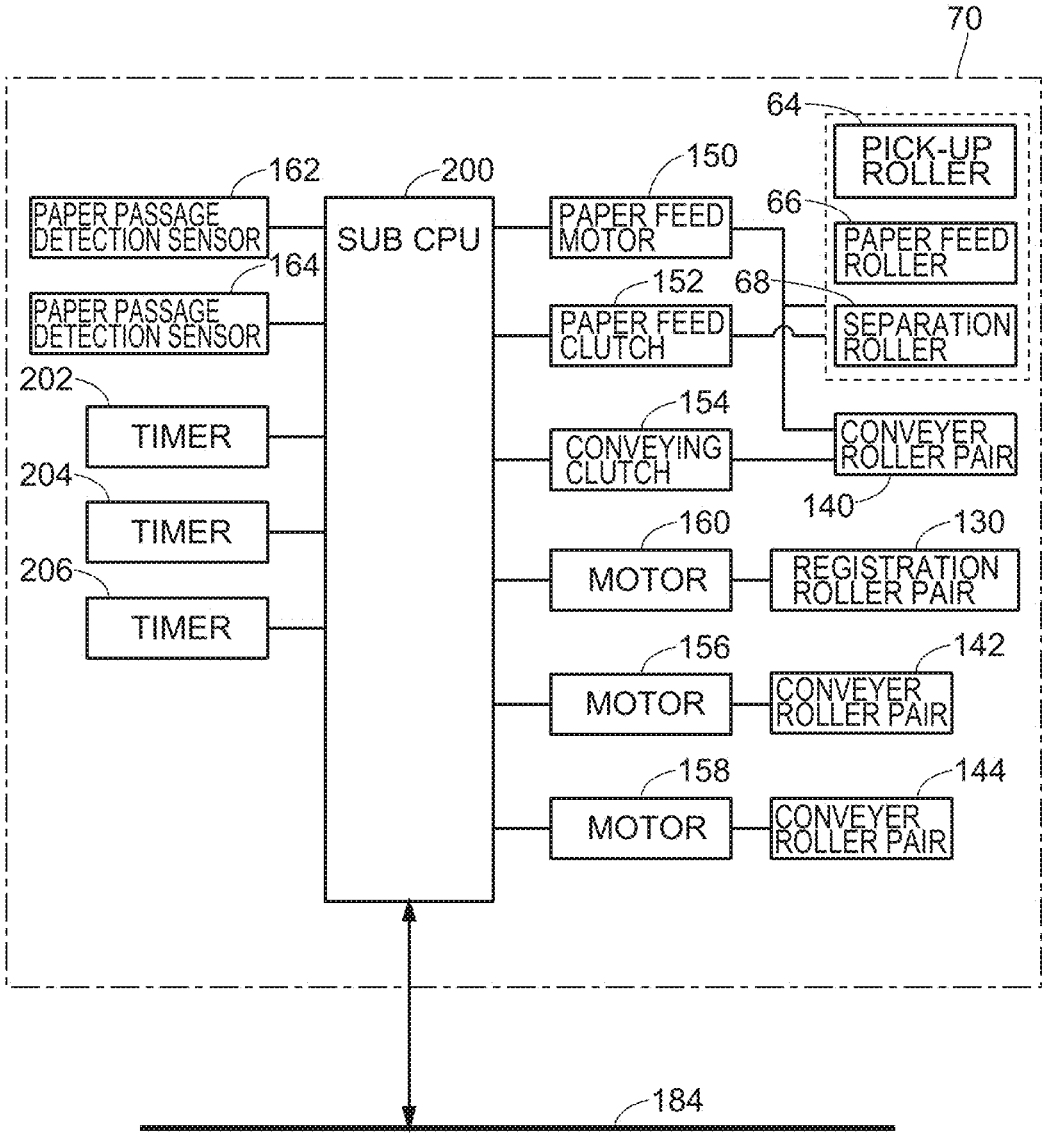

70
64
PICK-UP ROLLER
66
PAPER FEED ROLLER
68
SEPARATION ROLLER
162
PAPER PASSAGE DETECTION SENSOR
164
PAPER PASSAGE DETECTION SENSOR
200
SUB CPU
150
PAPER FEED MOTOR
152
PAPER FEED CLUTCH
154
CONVEYING CLUTCH
CONVEYER ROLLER PAIR
140
160
MOTOR
130
REGISTRATION ROLLER PAIR
156
MOTOR
142
CONVEYER ROLLER PAIR
158
MOTOR
144
CONVEYER ROLLER PAIR
202
TIMER
204
TIMER
206
TIMER
184

FIG. 10

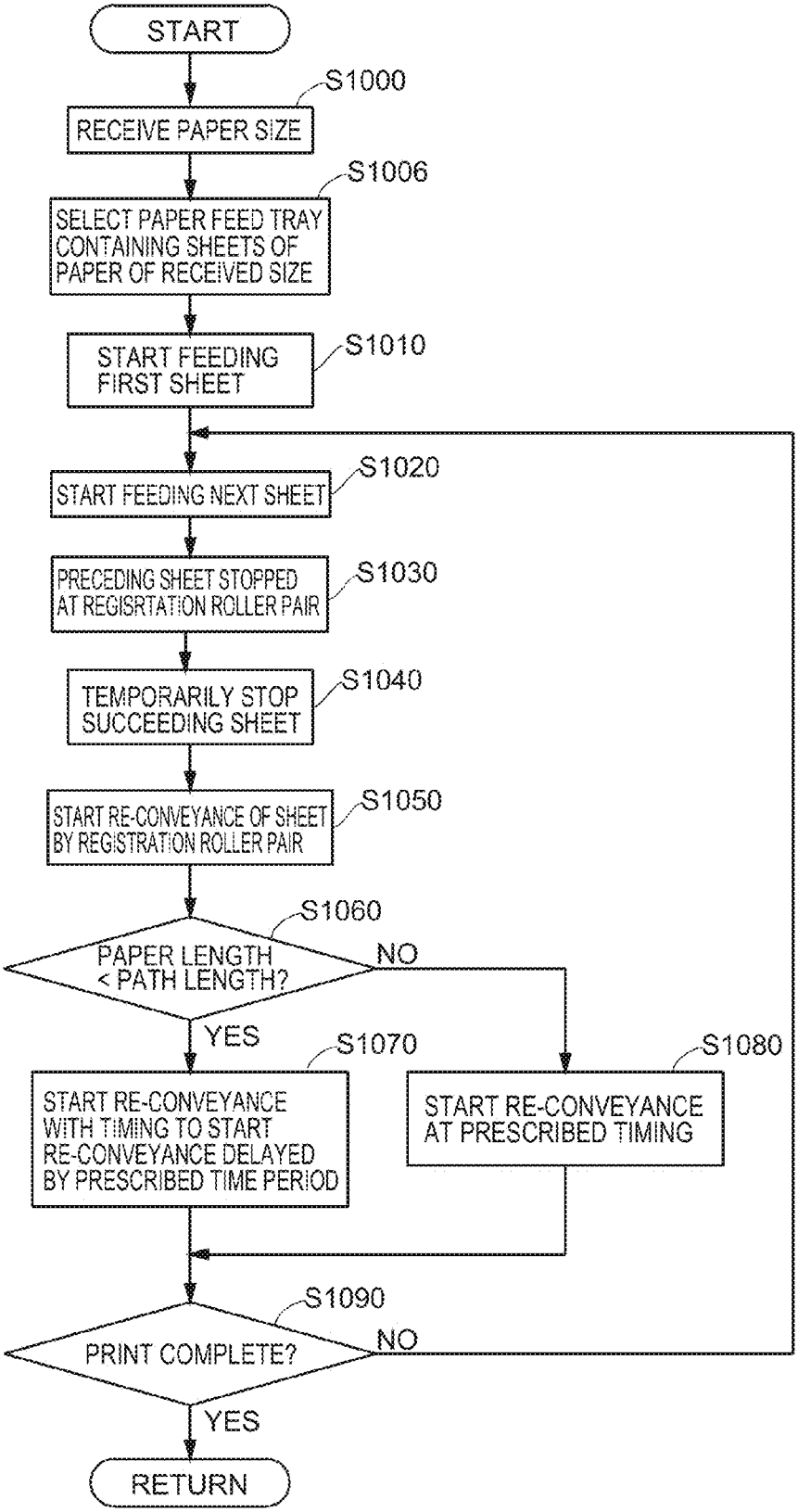

START
S1000
RECEIVE PAPER SIZE
S1006
SELECT PAPER FEED TRAY CONTAINING SHEETS OF PAPER OF RECEIVED SIZE
S1010
START FEEDING FIRST SHEET
S1020
START FEEDING NEXT SHEET
S1030
PRECEDING SHEET STOPPED AT REGISRTATION ROLLER PAIR
S1040
TEMPORARILY STOP SUCCEEDING SHEET
S1050
START RE-CONVEYANCE OF SHEET BY REGISTRATION ROLLER PAIR
S1060
PAPER LENGTH < PATH LENGTH?
NO
YES
S1070
START RE-CONVEYANCE WITH TIMING TO START RE-CONVEYANCE DELAYED BY PRESCRIBED TIME PERIOD
S1080
START RE-CONVEYANCE AT PRESCRIBED TIMING
S1090
PRINT COMPLETE?
NO
YES
RETURN

FIG. 11

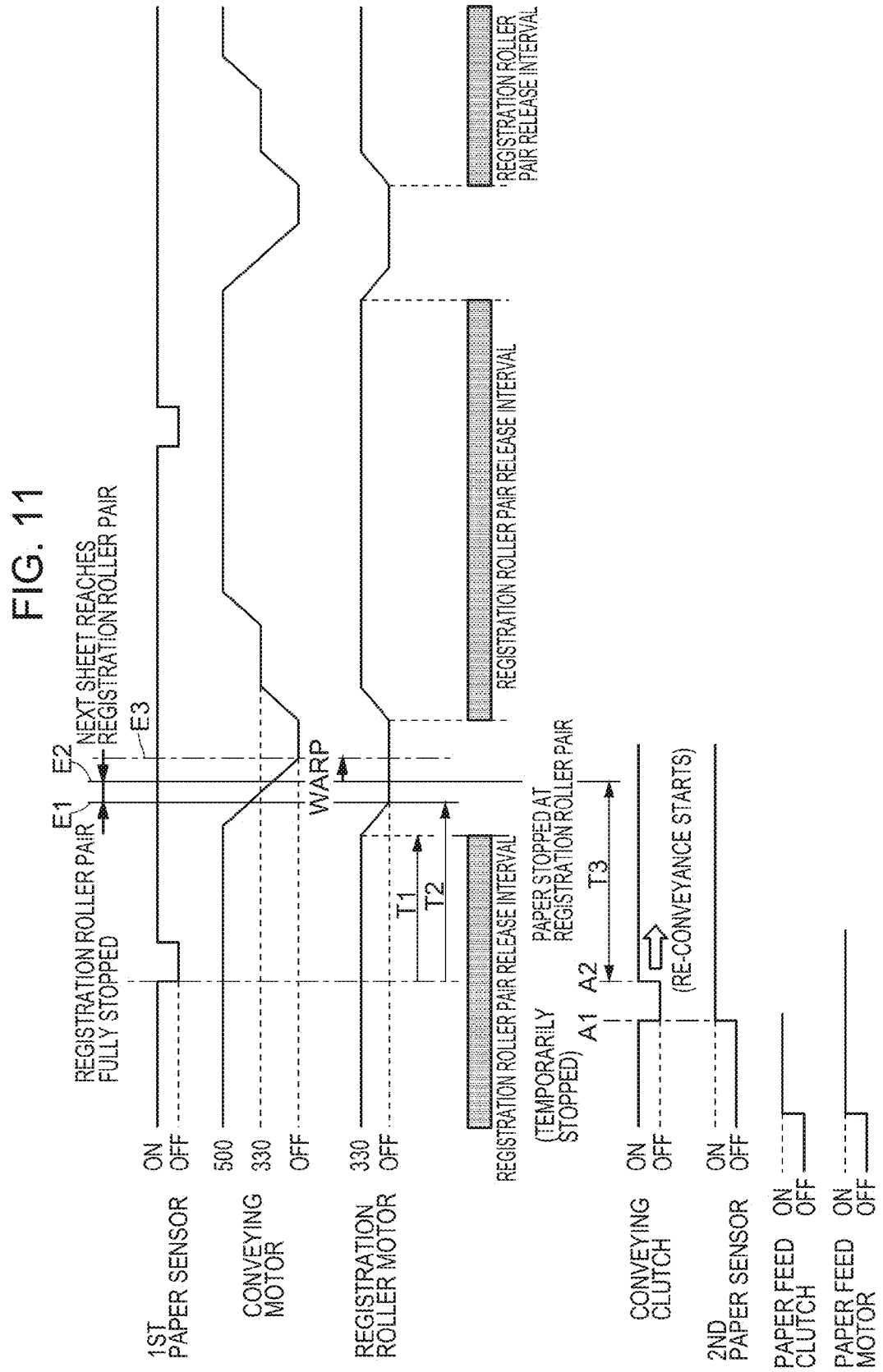
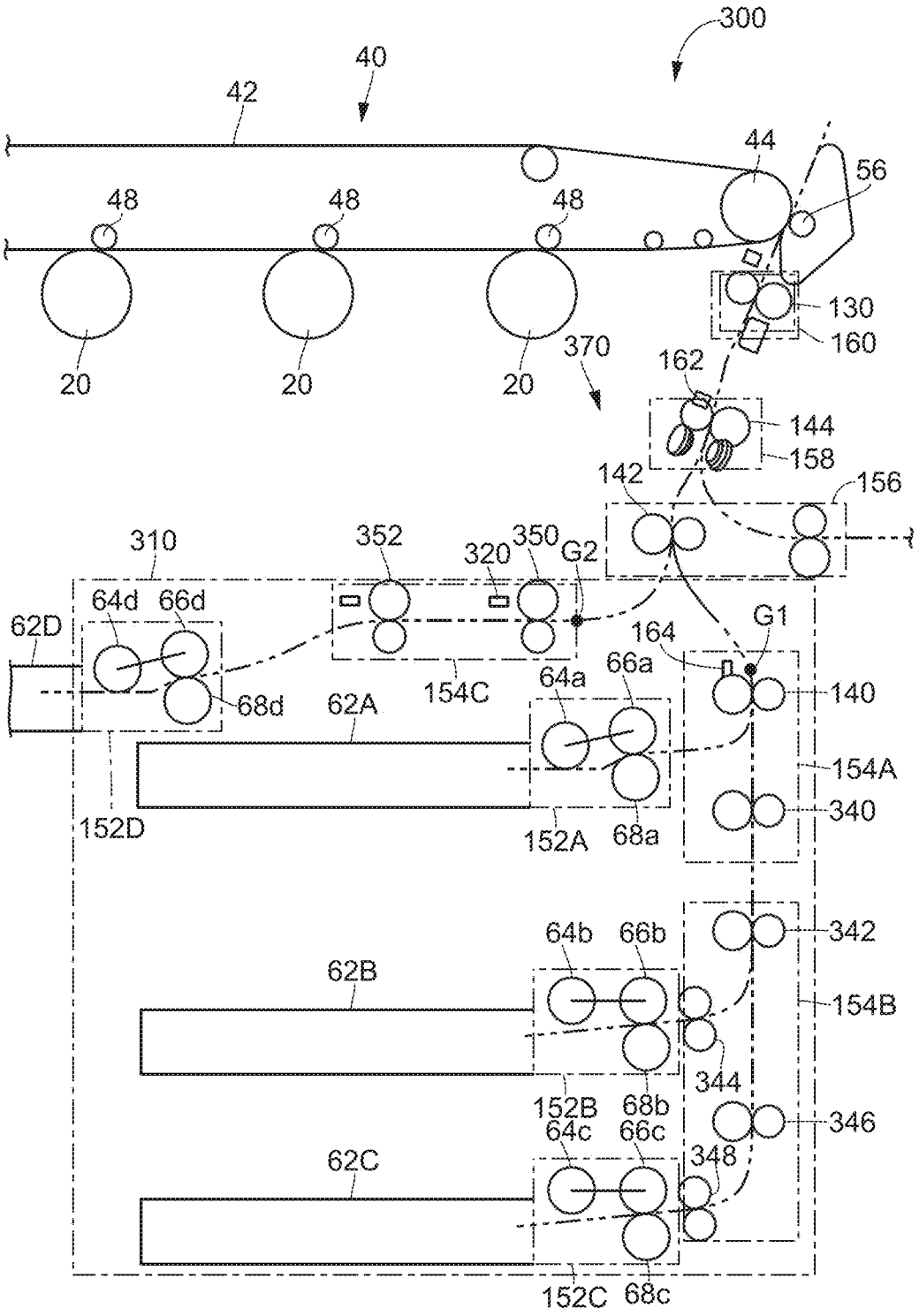

REGISTRATION ROLLER PAIR FULLY STOPPED
E1
E2
NEXT SHEET REACHES REGISTRATION ROLLER PAIR
E3
WARP
T1
T2
REGISTRATION ROLLER PAIR RELEASE INTERVAL
REGISTRATION ROLLER PAIR RELEASE INTERVAL
REGISTRATION ROLLER PAIR RELEASE INTERVAL
PAPER STOPPED AT REGISTRATION ROLLER PAIR
(TEMPORARILY STOPPED)
A1
A2
T3
(RE-CONVEYANCE STARTS)
1ST PAPER SENSOR
ON
OFF
CONVEYING MOTOR
500
330
OFF
REGISTRATION ROLLER MOTOR
330
OFF
CONVEYING CLUTCH
ON
OFF
2ND PAPER SENSOR
ON
OFF
PAPER FEED CLUTCH
ON
OFF
PAPER FEED MOTOR
ON
OFF

FIG. 12


300
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42
44
56
48
48
48
130
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20
20
370
162
144
158
142
156
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352
320
350
G2
64d
66d
62D
G1
164
66a
64a
68d
62A
154C
140
154A
340
152D
152A
68a
342
64b
66b
62B
154B
344
152B
68b
346
64c
66c
62C
348
152C
68c

FIG. 13

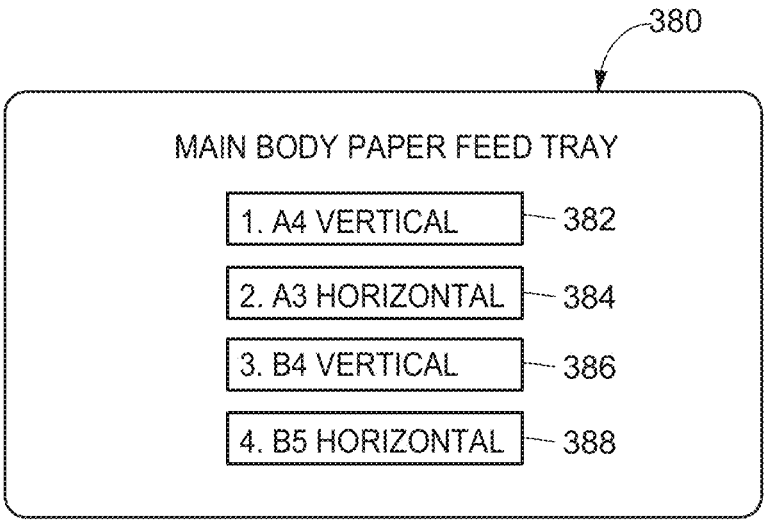

380
MAIN BODY PAPER FEED TRAY
1. A4 VERTICAL
382
2. A3 HORIZONTAL
384
3. B4 VERTICAL
386
4. B5 HORIZONTAL
388

FIG. 14

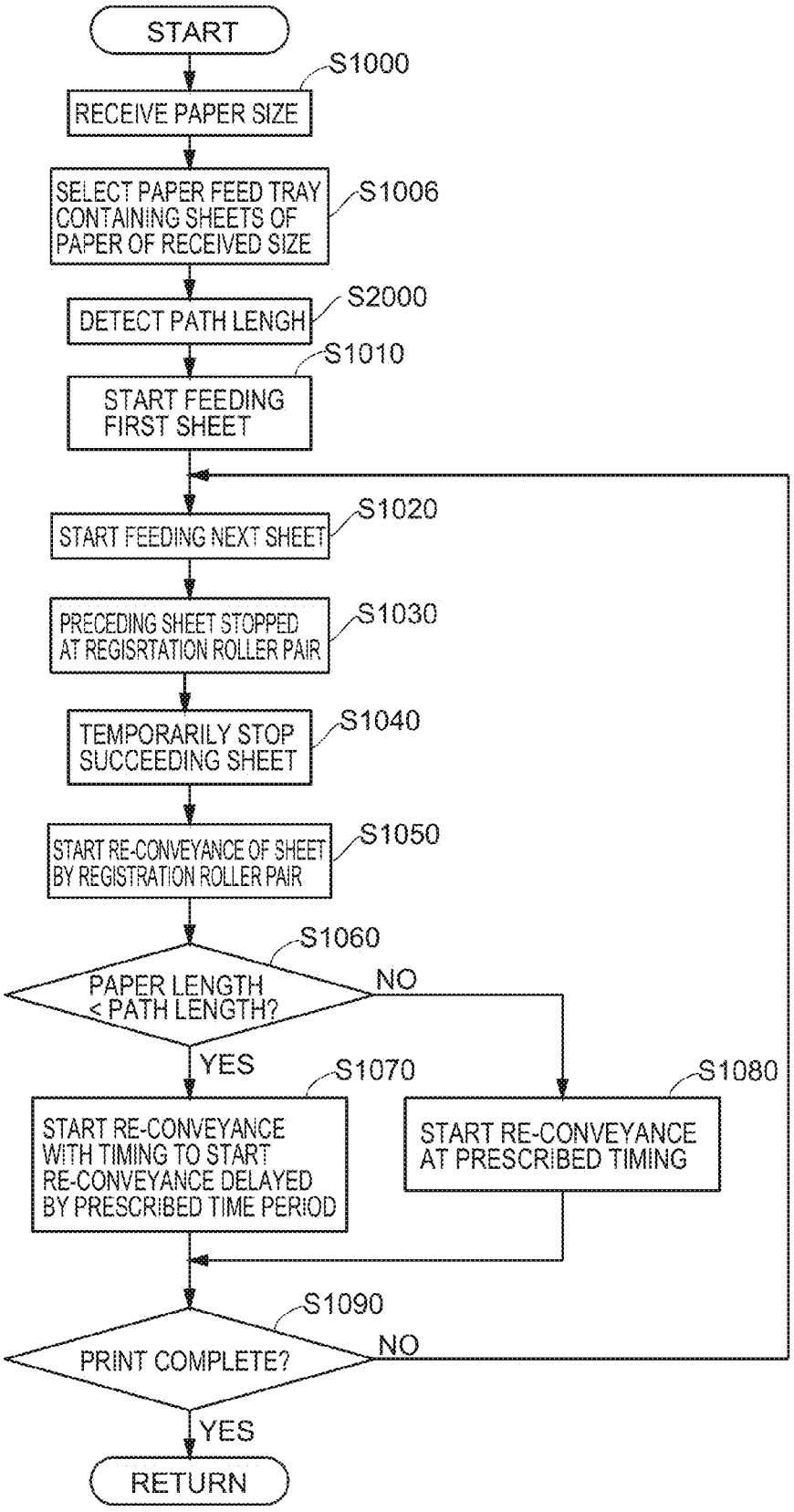

START
S1000
RECEIVE PAPER SIZE
SELECT PAPER FEED TRAY CONTAINING SHEETS OF PAPER OF RECEIVED SIZE
S1006
DETECT PATH LENGH
S2000
START FEEDING FIRST SHEET
S1010
START FEEDING NEXT SHEET
S1020
PRECEDING SHEET STOPPED AT REGISRTATION ROLLER PAIR
S1030
TEMPORARILY STOP SUCCEEDING SHEET
S1040
START RE-CONVEYANCE OF SHEET BY REGISTRATION ROLLER PAIR
S1050
PAPER LENGTH < PATH LENGTH?
S1060
NO
YES
START RE-CONVEYANCE WITH TIMING TO START RE-CONVEYANCE DELAYED BY PRESCRIBED TIME PERIOD
S1070
START RE-CONVEYANCE AT PRESCRIBED TIMING
S1080
PRINT COMPLETE?
S1090
NO
YES
RETURN

FIG. 15

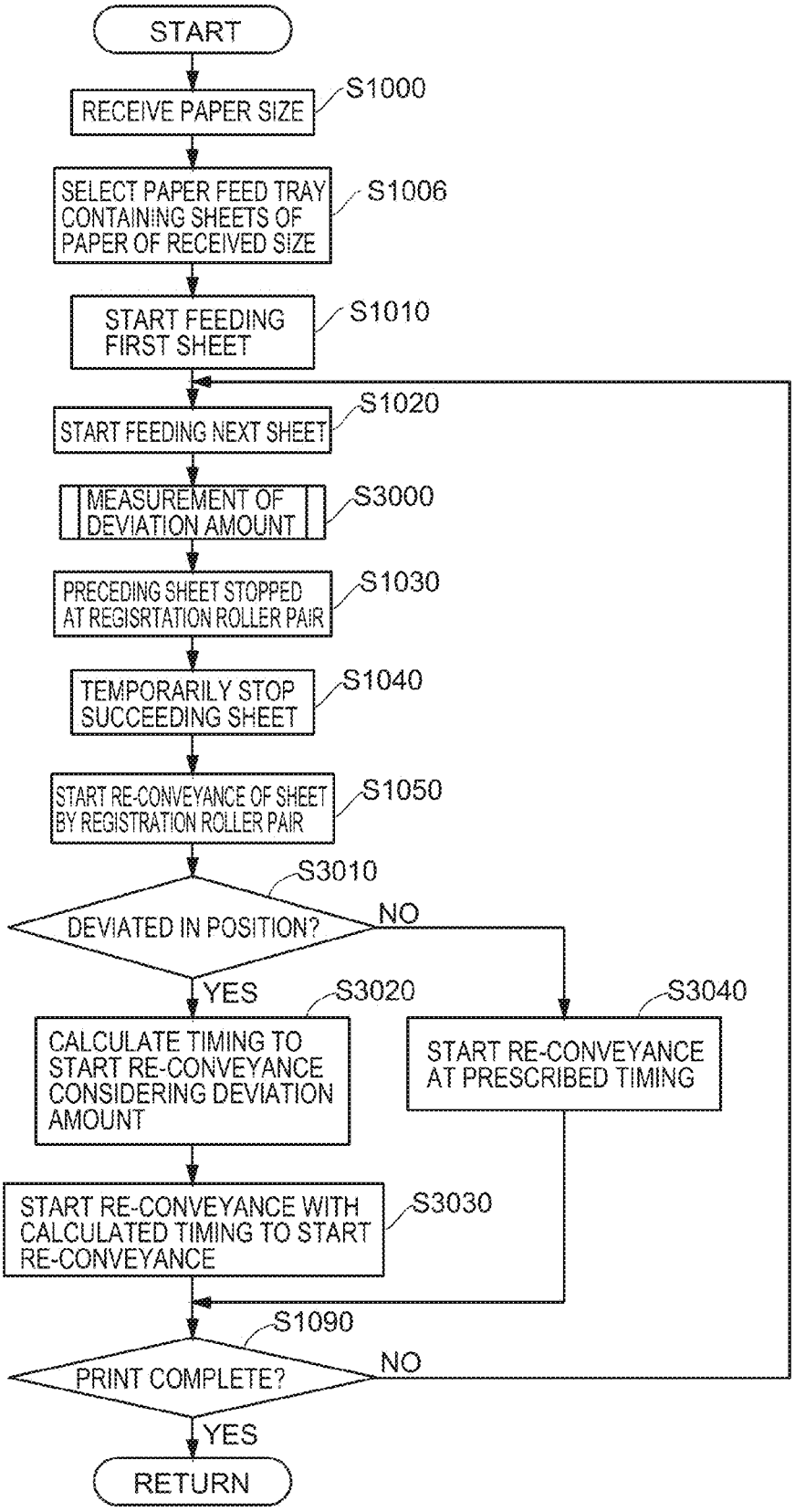

START
RECEIVE PAPER SIZE
S1000
SELECT PAPER FEED TRAY CONTAINING SHEETS OF PAPER OF RECEIVED SIZE
S1006
START FEEDING FIRST SHEET
S1010
START FEEDING NEXT SHEET
S1020
MEASUREMENT OF DEVIATION AMOUNT
S3000
PRECEDING SHEET STOPPED AT REGISRTATION ROLLER PAIR
S1030
TEMPORARILY STOP SUCCEEDING SHEET
S1040
START RE-CONVEYANCE OF SHEET BY REGISTRATION ROLLER PAIR
S1050
S3010
DEVIATED IN POSITION?
NO
YES
S3020
CALCULATE TIMING TO START RE-CONVEYANCE CONSIDERING DEVIATION AMOUNT
S3040
START RE-CONVEYANCE AT PRESCRIBED TIMING
START RE-CONVEYANCE WITH CALCULATED TIMING TO START RE-CONVEYANCE
S3030
S1090
PRINT COMPLETE?
NO
YES
RETURN

FIG. 16

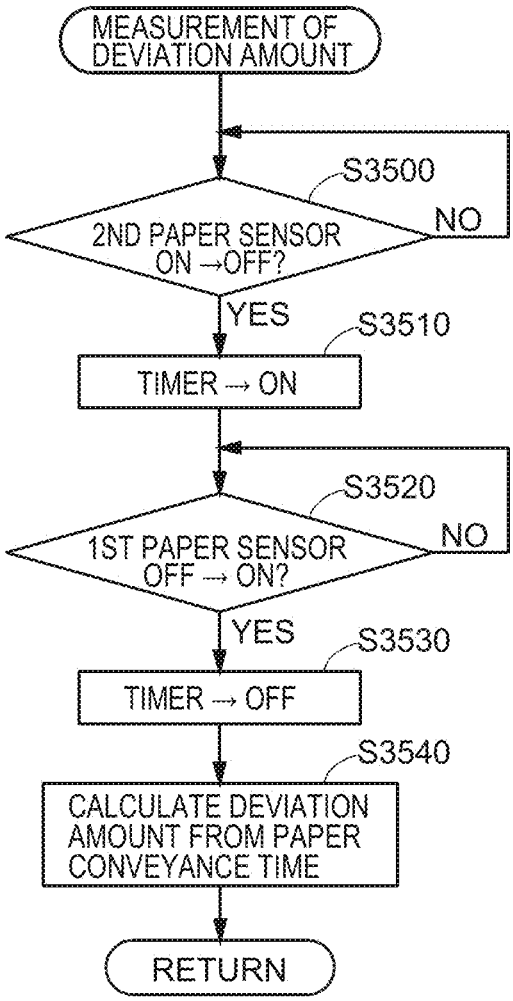

MEASUREMENT OF DEVIATION AMOUNT
S3500
2ND PAPER SENSOR ON →OFF?
NO
YES
S3510
TIMER → ON
S3520
1ST PAPER SENSOR OFF → ON?
NO
YES
S3530
TIMER → OFF
S3540
CALCULATE DEVIATION AMOUNT FROM PAPER CONVEYANCE TIME
RETURN

FIG. 17

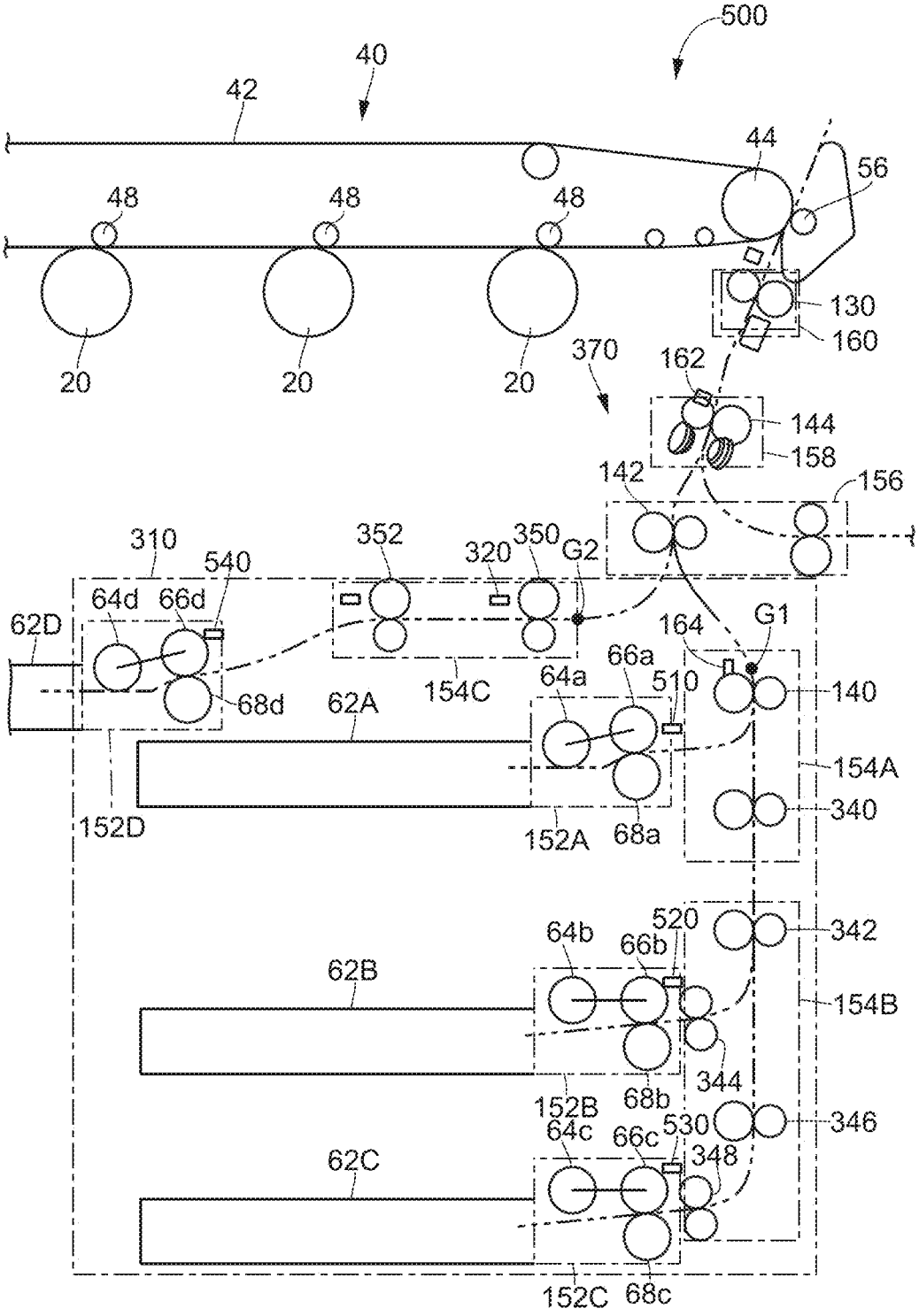
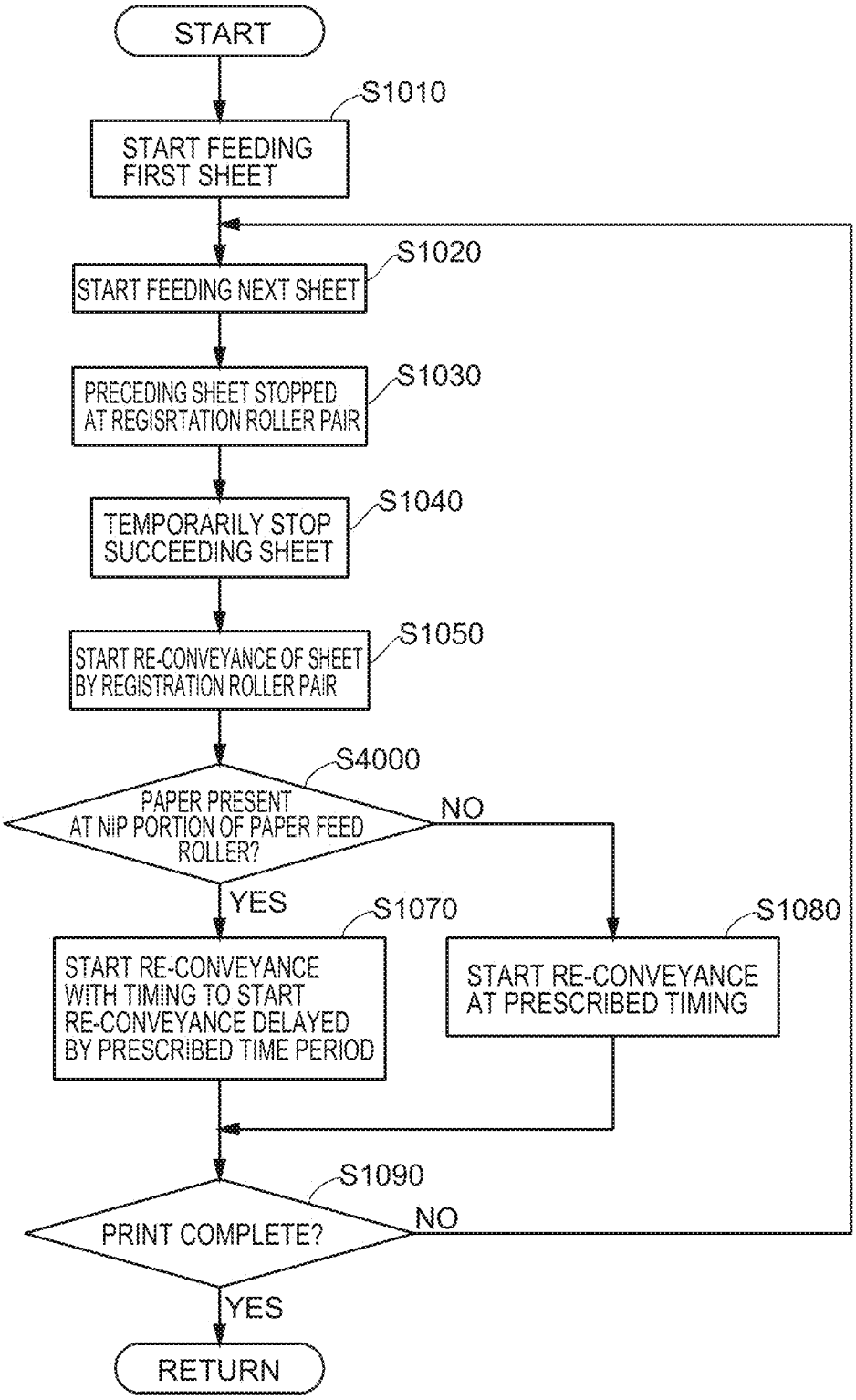

500
40
42
44
56
48
48
48
130
160
20
20
20
370
162
144
158
142
156
310
352
320
350
G2
540
64d
66d
62D
68d
62A
154C
64a
66a
510
164
G1
140
154A
340
152D
152A
68a
520
64b
66b
342
62B
154B
344
152B
68b
64c
66c
530
346
62C
348
152C
68c

FIG. 18


START
S1010
START FEEDING FIRST SHEET
S1020
START FEEDING NEXT SHEET
S1030
PRECEDING SHEET STOPPED AT REGISRTATION ROLLER PAIR
S1040
TEMPORARILY STOP SUCCEEDING SHEET
S1050
START RE-CONVEYANCE OF SHEET BY REGISTRATION ROLLER PAIR
S4000
PAPER PRESENT AT NIP PORTION OF PAPER FEED ROLLER?
NO
YES
S1070
START RE-CONVEYANCE WITH TIMING TO START RE-CONVEYANCE DELAYED BY PRESCRIBED TIME PERIOD
S1080
START RE-CONVEYANCE AT PRESCRIBED TIMING
S1090
PRINT COMPLETE?
NO
YES
RETURN

PAPER CONVEYING DEVICE, IMAGE FORMING APPARATUS PROVIDED WITH THE DEVICE AND PAPER CONVEYING METHOD

This application is the U.S. national phase of International Application No. PCT/JP2013/056964, filed 13 Mar. 2013, which designated the U.S. and claims priority to Japan Application No. 2012-061842, filed 19 Mar. 2012, the entire contents of each of which are hereby incorporated by reference.

TECHNICAL FIELD

The present invention relates to a paper conveying device, an image forming apparatus provided with the device, and a method of conveying paper. More specifically, the present invention relates to a paper conveying device capable of successively conveying a plurality of sheets of paper, an image forming apparatus provided with the device and a method of conveying sheets of paper.

BACKGROUND ART

As is well known, an image forming apparatus such as a printer or a copy machine is provided with a paper feed device for feeding sheets of paper one by one. The sheet of paper fed by the paper feed device is conveyed to a paper forming unit, in which image is formed. Between the paper feed device and the image forming unit, a pair of registration rollers is arranged for registering leading edge of the sheet and for skew correction. The conveyed sheet is once stopped at the pair of registration rollers for skew correction, and conveyed again to the image forming unit with timing adjusted for alignment with the image to be formed.

In a high-speed apparatus capable of high-speed printing, there is a demand to increase the number of copies per unit time (CPM: Copy Per Minute) as much as possible while not very much increasing the speed of image formation in copy-printing (process speed) (with the process speed kept as low as possible). In order to meet such a demand, it is desirable to make as narrow as possible the space or interval between a preceding sheet and a following, succeeding sheet, when the sheets are fed successively.

Patent Literature 1, which will be described later, proposes a method of controlling paper feeding and conveyance enabling feeding and conveyance of paper without reducing productivity. According to the method of controlling paper feeding and conveyance of Patent Literature 1, when the leading edge of preceding sheet is stopped at the registration roller pair, the trailing edge of the preceding sheet is detected by a sensor provided along a conveying path, and a trigger that determines the timing to start feeding of the next sheet is changed in accordance with the result of detection. Specifically, that the trailing edge of preceding sheet has passed through the sensor, or that re-conveyance of the preceding sheet after temporarily stop at the registration roller pair has started, is used as the trigger for determining the timing to start feeding of the next sheet, depending on the result of detection.

If the passage of trailing edge of preceding paper through the sensor is used as the trigger and the trailing edge of preceding sheet is stopped held on the paper conveying device while the leading edge of the preceding sheet is stopped at the registration roller pair, it follows that the time of passage through the sensor serving as a trigger to start feeding of the next sheet will be after re-conveyance of the preceding sheet by the registration roller pair. In that case, the interval between the sheets becomes too wide, leading to lower productivity.

Therefore, according to Patent Literature 1, if the sensor detects that the trailing edge of preceding sheet is stopped held on paper conveying device, the trigger to start feeding of the next sheet is changed to the start of re-conveyance of the preceding paper after temporary stop at the registration roller pair. In this manner, the interval between sheets of paper is made narrower, to prevent the paper interval from becoming too long.

CITATION LIST

Patent Literature

PTL 1: Japanese Patent Laying-Open No. 2007-161479

SUMMARY OF INVENTION

Technical Problem

By the technique of Patent Literature 1, however, the interval between the sheets is not sufficiently short and the above-described demand for increasing CPM as much as possible cannot be fully satisfied.

On the other hand, variation in conveyance sometimes occurs when sheets of paper are conveyed in an image forming apparatus. Such variation in conveyance has more significant influence on image formation as the interval between sheets becomes shorter. Therefore, with higher CPM, it becomes more difficult to realize successful printing on the sheets of paper. By way of example, if the interval between sheets is short, variation of conveyance increases the possibility that the succeeding sheet arrives at the registration roller pair before the registration roller pair stops rotation. In such a case, the arriving sheet enters a nip portion of the registration roller pair, making skew correction impossible. Further, since the sheet is fed earlier with respect to the image to be formed, position registration timing is missed and the images are varied in position. Since it has been difficult to increase CPM without sacrificing the print quality as described above, the CPM and the process speed have conventionally been determined within the range that can cope with such variation in conveyance.

The present invention was made to solve such a problem and its object is to provide a paper conveying device capable of conveying sheets of paper without lowering print quality and increasing the number of prints per unit time, an image forming apparatus provided with the device, and a method of conveying sheets of paper.

Solution to Problem

In order to attain the above-described object, according to a first aspect, the present invention provides a paper conveying device, including: paper feeding means for feeding a sheet of paper to a paper conveying path; registration means, provided along the paper conveying path, for temporarily stopping the conveyed sheet of paper and re-conveying the sheet of paper; conveyer means, provided in the paper conveying path from the paper feeding means to the registration means, for conveying the sheet of paper fed to the paper conveying path to the registration means; paper size receiving means for receiving information related to a size of the conveyed sheet of paper; and conveyance control means for controlling conveyance of the sheet of paper such that when a plurality of

sheets of paper are fed successively to the paper conveying path and a preceding sheet of paper is stopped at the registration means, a following, succeeding sheet of paper is temporarily stopped at a prescribed position downstream of the conveying means in the paper conveying direction, and then the sheet is re-conveyed toward the registration means at a prescribed timing. The conveyance control means includes re-conveyance start timing changing means for changing a timing to start re-conveyance of the succeeding sheet of paper in accordance with paper length in the paper conveying direction of the conveyed sheet of paper received by the paper size receiving means.

When the preceding sheet of paper is stopped at the registration means, the following, succeeding sheet is temporarily stopped at a prescribed position downstream of the conveying means in the paper conveying direction. Thus, the succeeding sheet is conveyed closer to the preceding sheet and kept in a standby state at that position. Thereafter, the sheet is conveyed again toward the registration means at a prescribed timing. Thus, the interval between the preceding and succeeding sheets can easily be made shorter.

Here, if the succeeding sheet is temporarily stopped, the load of the conveying system on the succeeding sheet may vary depending on the length of the sheet (length in the paper conveying direction). By way of example, if the sheet is long, when the leading edge of the sheet reaches the position of temporary stopping, the succeeding sheet will be held at the paper feeding means. In that case, the load of the conveying system (paper feed system) of the paper feeding means will be exerted on the succeeding sheet and, hence, the load of the conveying system on the succeeding sheet becomes large. The load makes it easier to stop the succeeding sheet at the temporary stopping position. On the other hand, if a sheet is short, when the leading edge of the sheet reaches the temporary stopping position, the succeeding sheet may not be held at the paper feeding means. In that case, the load of the conveying system (paper feed system) of the paper feeding means will not be exerted on the succeeding sheet, and hence, the load of the conveying system on the succeeding sheet becomes smaller. It becomes less easy to stop the succeeding sheet at the temporary stopping position and, therefore, the leading edge of the succeeding sheet will be stopped at a position on the side more downstream than the temporary stopping position, in the paper conveying direction. In this manner, depending on the length of conveyed sheet, the position where it is temporarily stopped deviates. Specifically, in accordance with the length of conveyed sheet, the load of conveying system becomes different, causing deviation in the position where the sheet is stopped. If the timing to start re-conveyance to the registration means is made constant regardless of such positional deviation, conveyance variation results.

Therefore, in the paper conveying device of the present invention, the timing to start re-conveyance of the succeeding sheet is changed, in accordance with the length of the conveyed sheet. Thus, the interval between the sheets at the registration means can be made constant. Consequently, the conveyance variation can be reduced even if CPM is increased. Since the conveyance variation can be reduced, the registration means can temporarily stop the conveyed sheet and re-convey the sheet. Thus, the skew correction of the sheet can be done successfully and the leading edge reference can be aligned by ensuring good timing for positional registration. As a result, degradation of print quality can be prevented. In this manner, the number of prints per unit time (CPM) can be increased as much as possible while not very much increasing the speed of image formation in copy-printing (process speed) (with the process speed kept as low as possible), and the productivity can be improved.

Preferably, the re-conveyance start timing changing means includes means for changing the timing to start re-conveyance of the succeeding sheet of paper based on a path length from the paper feeding means to the position at which the succeeding sheet of paper is temporarily stopped and on the paper length of the conveyed sheet of paper.

Based on the path length from the paper feeding means to the position where the succeeding sheet is temporarily stopped and on the length of conveyed sheet, the timing to start re-conveyance of succeeding sheet is changed, whereby the conveyance variation can easily be reduced.

More preferably, the re-conveyance start timing changing means includes means for determining whether the paper length of the conveyed sheet of paper is shorter than a path length from the paper feeding means to the position at which the succeeding sheet of paper is temporarily stopped, and changing the timing to start re-conveyance of the succeeding sheet of paper depending on the result of determination.

More preferably, when the paper length of the conveyed sheet of paper is determined to be shorter than the path length from the paper feeding means to the position at which the succeeding sheet of paper is temporarily stopped, the means for changing the timing delays the timing to start re-conveyance of the succeeding sheet of paper by a prescribed time period; and when the paper length of the conveyed sheet of paper is determined to be not shorter than the path length from the paper feeding means to the position at which the succeeding sheet of paper is temporarily stopped, the means for changing the timing does not change the timing to start re-conveyance of the succeeding sheet of paper.

Whether the paper length of conveyed sheet is longer than the path length from the paper feeding means to the position where the succeeding sheet is temporarily stopped is determined. When the length of conveyed sheet is determined to be shorter than the path length from the paper feeding means to the position where the succeeding sheet is temporarily stopped, the timing to start re-conveyance of the succeeding sheet is delayed by a prescribed time period. In this manner, the interval between sheets at the registration means can easily be kept constant. When the length of conveyed sheet is determined to be not shorter than the path length from the paper feeding means to the position where the succeeding sheet is temporarily stopped, it means that the succeeding sheet more easily stops at the temporary stopping position and, positional deviation is less likely at the temporary stopping position. In that case, the timing to start re-conveyance of the succeeding sheet is unchanged, and thus, the interval between the sheets at the registration means can easily be kept constant. Thus, by the configuration described above, conveyance variation can more easily be reduced.

More preferably, the paper conveying device further includes paper detection means, arranged close to the conveying means, at a prescribed position upstream of the registration means in the paper conveying direction, for detecting a state of conveyance of the sheet of paper, and the conveyance control means includes means for temporarily stopping the succeeding sheet of paper at the prescribed position downstream of the conveying means in the paper conveying direction, at a timing when the paper detection means detects a leading edge of the sheet.

Since the timing when the leading edge of the sheet is detected by the sheet detecting means is used as the trigger, it becomes easier to temporarily stop the succeeding sheet at the prescribed position downstream of the conveying means in

the paper conveying direction. Thus, it becomes easier to keep the succeeding sheet in the standby state closer to the preceding sheet.

More preferably, the paper conveying device further includes paper detection means, arranged close to the conveying means, at a prescribed position upstream of the registration means in the paper conveying direction, for detecting a state of conveyance of the sheet of paper, and the conveyance control means includes means for temporarily stopping the succeeding sheet of paper at the prescribed position downstream of the conveying means in the paper conveying direction, a prescribed time period after the paper detection means detects a leading edge of the sheet.

Since the timing a prescribed time period after the sheet detecting means detects the leading edge of the sheet is used as the trigger, it becomes easier to temporarily stop the succeeding sheet at the prescribed position downstream of the conveying means in the paper conveying direction. Thus, also by this approach, it becomes easier to keep the succeeding sheet in the standby state closer to the preceding sheet.

More preferably, the paper conveying device further includes: paper detection means, arranged close to the conveying means, at a prescribed position upstream of the registration means in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; and a plurality of paper containing means for containing sheets of paper to be fed to the paper conveying path. The conveyance control means temporarily stops any sheet of paper fed from the plurality of paper containing means to the paper conveying path, at the prescribed position downstream of the conveying means in the paper conveying direction, at a timing when the paper detection means detects a leading edge of the sheet.

Any sheet fed from the plurality of paper storage means to the paper conveying path will be temporarily stopped at the same position. Therefore, when the timing to start re-conveyance of succeeding sheet is to be changed in accordance with the length of conveyed sheet, it becomes easier to change the timing to start re-conveyance.

More preferably, the paper conveying device further includes: paper detection means, arranged close to the conveying means, at a prescribed position upstream of the registration means in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; and a plurality of paper containing means for containing sheets of paper to be fed to the paper conveying path. The conveyance control means temporarily stops any sheet of paper fed from the plurality of paper containing means to the paper conveying path, at the prescribed position downstream of the conveying means in the paper conveying direction, a prescribed time period after the paper detection means detects a leading edge of the sheet.

Any sheet fed from the plurality of paper storage means to the paper conveying path will be temporarily stopped at the same position. Therefore, when the timing to start re-conveyance of succeeding sheet is to be changed in accordance with the length of conveyed sheet, it becomes easier to change the timing to start re-conveyance.

More preferably, the paper conveying device further includes deviation amount measuring means for measuring amount of positional deviation generated when the succeeding sheet of paper is temporarily stopped at the prescribed position downstream of the conveying means in the paper conveying direction, and the re-conveyance start timing changing means includes means for changing the timing to start re-conveyance of the succeeding sheet of paper in accordance with the amount of positional deviation measured by the deviation amount measuring means.

Since the timing to start re-conveyance of succeeding sheet is changed in accordance with the amount of deviation measured by the deviation amount measuring means, it becomes easier to keep constant the interval between the sheets at the registration means. Thus, conveyance variation can more easily be reduced.

According to a second aspect, the present invention provides an image forming apparatus including image forming means for forming an image, and the paper conveying device in accordance with the first aspect described above, for conveying sheets of paper to the image forming means. By this configuration, an image forming apparatus capable of increasing the number of copies per unit time (CPM) as much as possible while not very much increasing the speed of image formation in copy-printing (process speed) (with the process speed kept as low as possible) can be provided.

According to a third aspect, the present invention provides a method of conveying paper, including the steps of: receiving information related to a size of a sheet of paper to be conveyed; successively feeding a plurality of sheets of paper by a paper feed unit to a paper conveying path; by a conveying section provided on said paper conveying path; conveying the sheets of paper fed to the paper conveying path to a registration roller pair; temporarily stopping, when a preceding sheet of paper is stopped at the registration roller pair, a following, succeeding sheet of paper at a prescribed position downstream of said conveying section in the paper conveying direction; and re-conveying the temporarily stopped sheet of paper to the registration roller pair at a prescribed timing. The step of re-conveyance includes a step of changing a timing to start re-conveyance in accordance with paper length of the conveyed sheet of paper in the paper conveying direction received at the receiving step.

When the preceding sheet is stopped at the registration roller pair, the following, succeeding sheet is temporarily stopped at a prescribed position downstream of the section in the paper conveying direction. Thus, the succeeding sheet is conveyed closer to the preceding sheet and kept in a standby state at that position. Thereafter, the sheet is conveyed again toward the registration roller pair at a prescribed timing. Thus, the interval between the preceding and succeeding sheets can easily be made narrower.

The timing to start re-conveyance of the succeeding sheet is changed, in accordance with the length of the conveyed sheet. Thus, the interval between the sheets at the registration roller pair can be made constant. Consequently, the conveyance variation can be reduced even if CPM is increased, and degradation of print quality can be prevented. As a result, the number of prints per unit time (CPM) can be increased as much as possible while not very much increasing the speed of image formation in copy-printing (process speed) (with the process speed kept as low as possible), and the productivity can be improved.

Advantageous Effects of Invention

As described above, by the present invention, a paper conveying device capable of conveying sheets of paper without lowering print quality and increasing the number of prints per unit time, an image forming apparatus provided with the device, and a method of conveying sheets of paper can easily be provided.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** shows an overall configuration (internal configuration) of the image forming apparatus in accordance with the first embodiment of the present invention.

FIG. **2** schematically shows a configuration of a main portion of the paper conveying unit in the image forming apparatus shown in FIG. **1**.

FIG. **3** schematically shows a configuration of a main portion of the paper conveying unit in the image forming apparatus shown in FIG. **1**.

FIG. **4** schematically shows a configuration of a main portion of the paper conveying unit in the image forming apparatus shown in FIG. **1**.

FIG. **5** is a plan view of a paper feed tray viewed from above.

FIG. **6** includes a side view FIG. **6**A of the paper feed tray and a plan view FIG. **6**B of the paper feed tray viewed from the backside, both showing the configuration of the paper feed tray.

FIG. **7** includes FIG. **7**A showing a relation between a paper size detecting member and a sensor unit, and FIG. **7**B showing a relation between each of the paper size detecting member, a spur gear body and a paper trailing edge plate, both showing the configuration of the paper feed tray.

FIG. **8** is a block diagram showing a hardware configuration of the image forming apparatus shown in FIG. **1**.

FIG. **9** is a block diagram showing an electrical configuration of the paper conveying unit.

FIG. **10** is a flowchart representing a control structure of a program executed in the image forming apparatus shown in FIG. **1**.

FIG. **11** is a timing chart representing a paper conveying operation at the paper conveying unit.

FIG. **12** schematically shows a configuration of a main portion of the paper conveying unit in the image forming apparatus in accordance with a second embodiment of the present invention.

FIG. **13** shows an example of a paper selection screen image.

FIG. **14** is a flowchart representing a control structure of a program executed by the image forming apparatus in accordance with the second embodiment.

FIG. **15** is a flowchart representing a control structure of a program executed by the image forming apparatus in accordance with the third embodiment.

FIG. **16** is a detailed flow of step **S3000** shown in FIG. **15**.

FIG. **17** schematically shows a configuration of a main portion of the paper conveying unit in the image forming apparatus in accordance with a fourth embodiment of the present invention.

FIG. **18** is a flowchart representing a control structure of a program executed by the image forming apparatus in accordance with the fourth embodiment.

DESCRIPTION OF EMBODIMENTS

In the following embodiments, the same components are denoted by the same reference characters. Their functions and names are also the same. Therefore, detailed description thereof will not be repeated. In the following, the image forming apparatus in accordance with the embodiments of the present invention will be described as a tandem-type, full-color apparatus. The apparatus, however, may be of a different type (for example, 4-cycle) full-color or monochrome apparatus.

(First Embodiment)

Referring to FIG. **1**, an image forming apparatus **100** in accordance with the present embodiment is an MFP (Multi-Function Peripheral) including copy and printer functions. Image forming apparatus **100** has a so-called laser type (electrophotographic) print function, utilizing a laser beam for exposure. The apparatus, however, may have a different type print function.

[Overall Configuration]

Image forming apparatus **100** forms a multi-color or monochrome image on a prescribed sheet of paper, based on image data read by a scanner, or image data transmitted from an external device such as a client personal computer (hereinafter referred to as a "client PC") **600** shown in FIG. **8**. For this purpose, image forming apparatus **100** includes an image forming unit **30** having a photoreceptor drum **20**, a transfer mechanism **40** for directly or indirectly transferring a toner image formed on photoreceptor drum **20** to a sheet of paper P, and a fixing unit **50** melting not-yet fixed toner of the toner image that has been transferred to the sheet of paper P and fixing the toner image on the sheet P.

Image forming apparatus **100** further includes a paper feed tray **62** serving as a paper storage unit **60** and capable of storing a plurality of sheets of paper P, and a paper conveying unit **70** conveying sheets of paper P fed from paper feed tray **62** to image forming unit **30**.

Image forming apparatus **100** mainly consists of a main body **110** and an automatic document feeder **120**. Main body **110** includes image forming unit **30**, transfer mechanism **40**, fixing unit **50**, paper feed tray **62**, paper conveying unit **70**, a paper discharge tray **90**, and a scanner unit **92**. Image forming unit **30** includes an exposure unit **32**, a developer **34**, photoreceptor drum **20**, a toner supplying device **36**, a cleaner unit **38** and a charger **22**.

Image data handled in image forming apparatus **100** is data corresponding to a color image using black (K), cyan (C), magenta (M) and yellow (Y). Therefore, in order to form four different latent images of respective colors, four developers **34**, four photoreceptor drums **20**, four chargers **22** and four cleaner units **38** are provided, and these components form four image stations for processing black, cyan, magenta and yellow, respectively.

At an upper portion of main body **110**, a platen **94** of transparent glass for placing a document is arranged. An automatic document feeder **120** is attached to main body **110** to be opened/closed with respect to platen **94**.

Below platen **94**, a scanner unit **92** for reading image information of a document is arranged. Below scanner unit **92**, exposure unit **32**, photoreceptor drum **20**, developer **34**, toner supplying device **36**, charger **22**, cleaner unit **38**, transfer mechanism **40**, fixing unit **50** and paper discharge tray **90** are arranged.

Exposure unit **32** has a function of exposing charged photoreceptor drum **20** in accordance with input image data and thereby forming latent electrostatic image in accordance with the image data on the surface of the drum. Exposure unit **32** is implemented as a laser scanning unit (LSU) including a laser emitting unit and a reflection mirror. In exposure unit **32**, optical elements including a polygon mirror for laser beam scanning and a lens and a mirror for guiding a laser beam reflected by the polygon mirror to photoreceptor drum **20** are arranged.

Photoreceptor drum **20** is arranged above exposure unit **32** and rotates in a prescribed direction under the control of driving means, not shown, and a controller **170** shown in FIG. **8**. Around photoreceptor drum **20**, developer **34**, charger **22** as an electric field generator, and cleaner unit **38** are arranged. Developer **34** is for developing the latent electrostatic image formed on each photoreceptor drum **20** by the toner of four colors (C, M, Y, K). Below developer **34**, a pair of registration rollers **130** is arranged on the upstream side in the paper conveying direction. Toner supplying device **36** is arranged

above developer **34**, and it supplies toner discharged from a toner container (not shown) filled with toner to developer **34**. Charger **22** is arranged close to an outer circumferential surface of photoreceptor drum **20**, to uniformly charge the surface of photoreceptor drum **20** to a prescribed potential. Cleaner unit **38** removes and recovers toner left on the surface of photoreceptor drum **20** after development and image formation.

Transfer mechanism **40** includes an intermediate transfer belt **42**, an intermediate transfer belt driving roller **44**, an intermediate transfer belt driven roller **46**, an intermediate transfer roller **48** and an intermediate transfer belt cleaning unit **58**. There are four intermediate transfer rollers **48**, corresponding to respective colors of C, M. Y and K. Around intermediate transfer belt driving roller **44**, intermediate transfer belt driven roller **46** and intermediate transfer roller **48**, intermediate transfer belt **42** is wound and driven to rotate. Each intermediate transfer roller **48** supplies transfer bias for transferring the toner image on the corresponding photoreceptor drum **20** to intermediate transfer belt **42**.

Intermediate transfer belt **42** is provided to be in contact with the four photoreceptor drums **20**. By successively transferring the toner images of respective colors formed on photoreceptor drums **20** superposed on intermediate transfer belt **42**, image forming apparatus **100** forms a color toner image (multi-color toner image) on intermediate transfer belt **42**. Intermediate transfer belt **42** is formed as an endless belt, using a film having the thickness of about 100 μm to 150 μm.

Transfer of the toner image from photoreceptor drum **20** to intermediate transfer belt **42** is done by intermediate transfer roller **48** that is in contact with the back side of intermediate transfer belt **42**. A high voltage transfer bias (high voltage of a polarity (+) opposite to the charged polarity (−) of the toner) is applied to intermediate transfer roller **48**, in order to transfer the toner image. Intermediate transfer roller **48** has a metal shaft (for example, of stainless steel) of 8 to 10 mm in diameter as a base, with its surface covered by a conductive elastic member (such as ethylene propylene diene rubber or urethane foam). Because of this conductive elastic member, uniform high voltage can be applied to intermediate transfer belt **42**. Though a roller-shaped transfer electrode is used in the present embodiment, a brush or the like may be used as an alternative.

The electrostatic images turned to visual images in accordance with the hue on respective photoreceptor drums **20** as described above are superposed or stacked on intermediate transfer belt **42**. Information of the thus superposed images is transferred to a sheet of paper P, as intermediate transfer belt **42** is rotated, by a transfer roller **56** arranged at the position of contact between the intermediate transfer belt **42** and the sheet of paper P.

Here, intermediate transfer belt **42** and transfer roller **56** are brought into pressure-contact with a prescribed nip, and a voltage (high voltage of a polarity (+) opposite to the charged polarity (−) of the toner) for transferring the toner to the sheet of paper P is applied to transfer roller **56**. Further, in order to constantly secure the nip mentioned above, a hard material (metal or the like) is used for one of the transfer roller **56** and intermediate transfer belt driving roller **44**, and a soft material such as soft roller (elastic rubber roller, foam resin roller or the like) is used for the other one.

Further, as described above, the toner adhering to intermediate transfer belt **42** by the contact with photoreceptor drum **20**, or toner not transferred to the sheet of recording paper by transfer roller **56** but left on intermediate transfer belt **42** may cause undesirable mixture of toner colors in succeeding process steps. Therefore, the toner adhering to or left on intermediate transfer belt **42** is removed and recovered by intermediate transfer belt cleaning unit **58**. In intermediate transfer belt cleaning unit **58**, a cleaning blade that is brought into contact with intermediate transfer belt **42** is provided as a cleaning member. Intermediate transfer belt **42** is supported by intermediate transfer belt driven roller **46** from the backside at a portion where the cleaning blade contacts.

The latent electrostatic image transferred to the sheet of paper P by transfer mechanism **40** is fed to fixing unit **50**, at which the toner image is pressed and heated, whereby not-yet-fixed toner is melt and fixed on the sheet of paper P.

Fixing unit **50** includes a heat roller **52** and a pressure roller **54**. Fixing unit **50** heats and melts not-yet fixed toner on the conveyed sheet of paper P by means of heat roller **52** at a portion of pressure contact, a so-called nip portion, between heat roller **52** and pressure roller **54**, and by the anchoring function of pressure-contact force between heat roller **52** and pressure roller **54**, fixes the not-yet-fixed toner on the sheet of paper P. At fixing unit **50**, a heater (halogen heater or the like) is provided for heating heat roller **52**.

In the vicinity of fixing unit **50**, a paper discharge roller **24** for discharging the sheet of paper P to paper discharge tray **90** is provided.

Paper feed tray **62** is for containing sheets of paper P to be used for image formation, provided below exposure unit **32** in main body **110**. Sheets of paper P to be used for image formation can also be placed on a manual feed tray **82**. Discharge tray **90** provided at an upper portion of main body **110** is for stacking printed sheets of paper in a face-down manner.

In order to feed the sheets of paper from paper feed tray **62** or manual feed tray **82** through transfer roller **56** and fixing unit **50** to discharge tray **90**, an approximately vertical paper conveying path S is provided in main body **110**.

Paper conveying unit **70** has a conveying system for conveying the sheets of paper P. The conveying system includes a paper feeding system for feeding paper P from paper feed tray **62** to the paper conveying path S which leads to image forming unit **30**, and a paper conveying system for conveying the paper P from the paper feeding system to the image forming unit **30** through paper conveying path S.

The paper feeding system of paper conveying unit **70** includes, in order to feed the sheets of paper P in paper feed tray **62** one by one to the paper conveying path S, a pick-up roller **64** and a paper feed roller **66** and a separation roller **68** positioned as a pair of upper/lower rollers to function as a separating roller pair. By the rotation of these rollers **64**, **66** and **68**, the sheets of paper P stacked and contained in paper feed tray **62** are picked-up one by one from the uppermost one and fed to the paper conveying system of paper conveying path S. The paper conveying system includes three pairs of conveyer rollers **140**, **142** and **144**. These conveyer roller pairs **140**, **142** and **144** are arranged in this order from the upstream side to the downstream side of the paper conveying direction, on the paper conveying path S from the paper feeding system to registration roller pair **130**. Pick-up roller **64**, paper feed roller **66** and separation roller **68** are arranged at a paper discharging end of paper feed tray **62**. The sheet of paper P fed from paper feed tray **62** to the paper conveying system by the operation of these rollers **64**, **66** and **68** is conveyed by the rotation of conveyer roller pairs **140**, **142** and **144** to registration roller pair **130** provided along the paper conveying path S.

Referring to FIG. **2**, paper conveying unit **70** further includes a paper feed motor **150**, a paper feed clutch **152**, a vertical conveying clutch **154**, a conveying motor **156**, a conveying motor **158** and a registration roller motor **160**. Paper feed motor **150** drives pick-up roller **64**, paper feed roller **66**,

separation roller **68** and conveyer roller pair **140**. Paper feed clutch **152** transmits driving force of paper feed motor **150** to pick-up roller **64**, paper feed roller **66** and separation roller **68**. Vertical conveying clutch **154** transmits the driving force of paper feed motor **150** to conveyer roller pair **140**. Paper feed clutch **152** and vertical conveying clutch **154** are electromagnetic, or electric clutch. When paper feed clutch **152** is turned on, the driving force of paper feed motor **150** is transmitted to pick-up roller **64**, paper feed roller **66** and separation roller **68** and, hence, these rollers rotate. On the other hand, when paper feed clutch **152** is turned off, transmission of driving force of paper feed motor **150** is interrupted, and these rollers **64**, **66** and **68** do not rotate. Similarly, when vertical conveying clutch **154** is turned on, the driving force of paper feed motor **150** is transmitted to conveyer roller pair **140**, and conveyer roller pair **140** rotates. On the other hand, when vertical conveying clutch **154** is turned off, transmission of driving force of paper feed motor **150** is interrupted, and conveyer roller pair **140** does not rotate. Conveying motors **156** and **158** drive conveyer roller pairs **142** and **144**, respectively. Registration roller motor **160** drives registration roller pair **130**.

Registration roller pair **130** is for temporarily holding the sheet of paper P that is being conveyed through paper conveying path S. It has a function of conveying the sheet of paper P to transfer roller **56** at timing when the toner image on photoreceptor drum **20** is aligned with the leading edge of sheet P. More specifically, registration roller pair **130** has its operation controlled by registration roller motor **160** and a controller **170**, shown in FIG. **8**, such that the sheet of paper P is conveyed between intermediate transfer belt **42** and transfer roller **56** with the leading edge of sheet P fed from paper feed tray **62** aligned with the toner image on intermediate transfer belt **42**.

In the vicinity of pre-registration conveyer roller **144** arranged before (on the upstream side of) registration roller pair **130**, a first paper passage detection sensor **162** is provided. By the control of controller **170**, if the first paper passage detection sensor **162** detects conveyance of a sheet of paper P, registration roller pair **130** is stopped at a timing a prescribed time period after the detection. Thus, the sheet of paper P is temporarily stopped at registration roller pair **130**.

At a prescribed position near the conveyer roller pair **140** and on the upstream side of registration roller pair **130** in the paper conveying direction, a second paper passage detection sensor **164** is provided for detecting the state of conveyance of paper P. Pick-up roller **64**, paper feed roller **66**, separation roller **68** and conveyer roller pair **140** have their operations controlled by paper feed roller **66** and controller **170** shown in FIG. **8** such that if the second paper passage detection sensor **164** detects a leading edge of a sheet of paper P, the sheet of paper P is temporarily stopped at the timing of detection.

More specifically, when a plurality of sheets of paper P are fed successively to paper conveying path S and a leading edge of a sheet (succeeding sheet) is detected by the second paper passage detection sensor **164** while a preceding sheet is stopped at registration roller pair **130**, image forming apparatus **100** temporarily stops the sheet. Therefore, the succeeding sheet is temporarily stopped at a prescribed position G on the downstream side of conveyer roller pair **140** in the paper conveying direction. The succeeding sheet is conveyed closer to the preceding sheet and kept standby at that position. Thereafter, the succeeding sheet is conveyed again toward registration roller pair **130** at a prescribed timing.

As the first and second paper passage detection sensors **162** and **164**, a sensor detecting passage of a sheet of paper in non-contact manner, such as an optical sensor or an ultrasonic sensor, is used.

Paper feed tray **62** is provided with a sensor unit for detecting the size of paper P contained therein.

Referring to FIGS. **5** and **6**, paper feed tray **62** includes a frame **260**, a paper trailing end plate **262** for aligning trailing ends of sheets of paper P contained therein, a spur gear **266** provided on the back side surface of paper feed tray **62**, a paper size detection member **270**, and a sensor unit **272**. Paper trailing end plate **262** is provided movable in the direction of an arrow X along a sliding slit **264**. Referring to FIG. **6**, on the back side of paper trailing end plate **262**, a pin **262***a* is provided, protruding downward. Spur gear **266** is pivotably supported by a pin **268**, and it has a slit **266***a* to be engaged with a pin **262***a* of paper trailing end plate **262**, and includes a gear portion **266***b*. Paper size detection member **270** includes a gear portion **270***a* to be engaged with the gear portion **266***b* of spur gear **266**, and has notches **270***b* and **270***c*. Sensor unit **272** includes a plurality of (in the present embodiment, three) switches **272***a*. **272***b* and **272***c*. When paper trailing end plate **262** moves in the X direction along sliding slit **264**, since pin **262***a* of paper trailing end plate **262** is engaged with the slit **266***a* of spur gear **266**, spur gear **266** rotates in the direction M.

Referring to FIG. **7**, spur gear **266** has its gear portion **266***b* engaged with gear portion **270***a* of paper size detection member **270** and, therefore, when spur gear **266** rotates, paper size detection member **270** moves in the X direction. Switches **272***a*, **272***b* and **272***c* of sensor unit **272** are arranged near paper size detection member **270**. Each of the switches **272***a*, **272***b* and **272***c* is a push-type switch, and when paper size detection member **270** rotates and touches the switch, the switch of sensor unit **272** turns on. When paper size detection member **270** moves and notches **270***b* and **270***c* of paper size detection member **270** come to the positions of switches **272***a* and **272***c*, switches **272***a* and **272***c* turn off. By the combination of on/off of switches **272***a*, **272***b* and **272***c*, the size of contained paper P is detected. Here, the direction of arrangement of paper P is also detected and, hence, the length of paper P in the paper conveying direction is also detected.

When paper feed tray **62** is set in main body **110**, sensor unit **272** transmits information related to the detected paper size to controller **170** shown in FIG. **8**. Image forming apparatus **100** stores the information related to the paper size transmitted from sensor unit **272** to controller **170**, for example, in RAM **176**, in association with paper feed tray **62**. Specifically, when sheets of paper of A4 size are stacked and contained in paper feed tray **62** and the paper feed tray **62** is set in main body **110**, sensor unit **272** detects that the paper contained in paper feed tray **62** is of A4 size. RAM **176** stores that paper feed tray **62** contains paper of A4 size.

When a document is to be copy-printed, image forming apparatus **100** reads image information of the document by scanner unit **92** and, at that time, detects the paper size of the document. Receiving a detection signal related to the paper size, controller **170** shown in FIG. **8** looks up information related to the paper size stored in RAM **176** and selects a paper feed tray containing the sheet of paper having the received paper size, and feeds paper P from the selected paper feed tray to the paper conveying path S.

When printing is to be done based on image data transmitted from an external device such as a client PC **600**, the image data (print data) transmitted from the external device includes a command indicating which size of paper is to be used for printing. Therefore, receiving the command (information

related to the paper size), image forming apparatus **100** (controller **170**) looks up the information related to the paper size stored in RAM **176**, and selects the paper feed tray containing the paper of the size instructed by the received command. Then, paper is fed from the selected paper feed tray to the paper conveying path S.

Referring to FIG. **3**, if the length of conveyed sheet of paper P is longer than the distance (path length) from the nip portion between paper feed roller **66** and separation roller **68** to the position G at which the sheet P is temporarily stopped, it follows that when the leading edge of a sheet of paper P (P**2**) reaches the temporary stopping position G, the sheet of paper P**2** is pinched at the nip portion between paper feed roller **66** and separation roller **68**. Specifically, the succeeding sheet of paper P**2** is retained at the nip portion between paper feed roller **66** and separation roller **68**. In this situation, load of the paper feeding system is added on the succeeding sheet of paper P**2** and, therefore, the load of the conveying system on the succeeding sheet of paper P**2** increases. Because of the increased load, the succeeding sheet of paper tends to be more easily stopped at the temporary stop position G. Thus, the amount of deviation of paper P from the position G becomes very small, and the sheet of paper P substantially stops at the designed position.

On the other hand, referring to FIG. **4**, if the length of conveyed sheet of paper P is shorter than the distance (path length) from the nip portion between paper feed roller **66** and separation roller **68** to the position G at which the sheet P is temporarily stopped, it follows that when the leading edge of a sheet of paper P (P**4**) reaches the temporary stopping position G, the sheet of paper P**4** is already out of the nip portion between paper feed roller **66** and separation roller **68** (completely freed from the nip portion). In this situation, the load of the paper feeding system is not exerted on the succeeding sheet of paper P**4** and, therefore, the load on the succeeding sheet of paper P**4** becomes smaller. It becomes more difficult to stop the succeeding sheet of paper P**4** at the temporary stop position G and, therefore, the stop position of the leading edge of succeeding sheet of paper P**4** is shifted to the downstream side than the temporary stop position G in the paper conveying direction. The amount of deviation is approximately constant, and it can be detected (measured) in advance by measurement. Data related to the timing to start re-conveyance of succeeding sheet of paper P**4** considering the amount of deviation is stored in a storage unit of ROM **174**, RAM **176** or HDD **178** (see FIG. **8**). It is noted that if the length of paper P is shorter than the path length described above, the paper P is shifted to the downstream side of temporary stop position G in the paper conveying direction and, therefore, the timing to start re-conveyance is delayed by a prescribed time period than the pre-set (normal) timing.

As described above, depending on the length of conveyed sheet of paper, the position G at which the sheet is temporary stopped deviates. Specifically, the load of the conveying system differs depending on the length of conveyed paper, resulting in a difference in the stopping position.

In the present embodiment, the length of conveyed paper is detected and the timing to start re-conveyance of the succeeding sheet of paper is changed in accordance with the length. Specifically, if the length of paper P is longer than the path length mentioned above, the sheet stops at the temporary stop position G and, therefore, re-conveyance starts at the normal timing to start re-conveyance. On the other hand, if the length of sheet P is shorter than the path length mentioned above, re-conveyance starts at a timing of re-conveyance considering the amount of deviation. Thus, even when the stop position differs, the positional deviation can be corrected, and when reaching registration roller pair **130**, variations in conveyance can be reduced. Thus, the interval between the sheets can be kept constant at the registration roller pair **130**.

[Hardware Configuration]

Referring to FIG. **8**, image forming apparatus **100** includes controller **170** for overall control of image forming apparatus **100**.

Controller **170** is effectively a computer including a main CPU **172**, an ROM **174**, an RAM **176**, an HDD (Hard Disk Drive) **178**, an image memory and an image processing unit **182**.

To main CPU **172**, a common bus line **184** is connected, and to this bus line **184**. ROM **174**, RAM **176**, HDD **178**, image memory **180** and image processing unit **182** are connected.

Main CPU **172** executes a computer program for realizing the paper conveying process in accordance with the present embodiment, and thereby realizes the function of paper conveying unit **70** shown in FIG. **9**. The program executed by main CPU **172** is stored in ROM **174** or HDD **178**.

RAM **176** also stores information related to the size of paper P contained in paper feed tray **62**, in association with paper feed tray **62**. Specifically, RAM **176** stores which size of paper is contained in paper feed tray **62**. The information related to the paper size includes paper size, the direction of paper arrangement and length of paper in the paper conveying direction.

At the time of execution, the program stored in ROM **174** or HDD **178** is read from ROM **174** or HDD **178** and loaded to RAM **176**, read from an address in RAM **176** indicated by a register functioning as a program counter in main CPU **172**, and interpreted and executed by main CPU **172**. Data necessary for the execution is read from an address designated by an instruction of HDD **178**, RAM **176** or the register mentioned above in main CPU **172**. Similarly, the result of execution is also stored at an address designated by an instruction of HDD **178**, RAM **176** or the register mentioned above in main CPU **172**.

To common bus line **184**, image forming unit **30**, transfer mechanism **40**, fixing unit **50**, paper conveying unit **70**, automatic document feeder **120** and scanner unit **92** are connected and, in addition, an operation unit **190** of image forming apparatus **100** and an NIC (Network Interface Card) **188** for providing an interface with a client PC **600** as an external device through a LAN (Local Area Network) line **610** are also connected. Therefore, main CPU **172** realizes desired operations of document reading, document output, paper feeding and discharging and communication with an external device such as client PC **600**, and stores or reads data to/from RAM **176**, HDD **178** and image memory **180**, by controlling image forming unit **30**, transfer mechanism **40**, fixing unit **50**, paper conveying unit **70**, automatic document feeder **120**, scanner unit **92** and NIC **188**.

Operation unit **190** is provided on a front side of main body **110**, and a start key **192**, a display panel **194** and the like are provided on operation unit **190**.

The conveyance program in accordance with the present embodiment is transmitted from another apparatus through LAN line **610** and NIC **188** to controller **170** substantially functioning as a computer, and stored in ROM **174** or HDD **178**.

[Electric Configuration of Paper Conveying Unit **70**]

Referring to FIG. **9**, paper conveying unit **70** includes a sub CPU **200** as a center of control of paper conveying unit **70**.

Sub CPU **200** is connected to a common bus line **184**, and through bus line **184**, it transmits/receives various data and the like to/from main CPU **172** shown in FIG. **8**. To sub CPU

200 are connected: motors 150, 156 and 158 as driving sources, respectively, of three conveyer roller pairs 140, 142 and 144 forming the paper conveying system; registration roller motor 160 driving registration roller pair 130; paper passage detection sensors 162 and 164; and in addition, first, second and third timers 202, 204 and 206. To sub CPU 200 are further connected: a paper feed motor 150 as a driving source of each of pick-up roller 64, paper feed roller 66, separation roller 68 and conveyer roller pair 140; a paper feed clutch 152 transmitting driving force of paper feed motor 150 to pick-up roller 64, paper feed roller 66 and separation roller 68; and a vertical conveying clutch 154 transmitting driving force of paper feed motor 150 to conveyer roller pair 140. The motor as a driving source of conveyer roller pair 140 is the paper feed motor 150.

Sensing outputs of each of paper passage detection sensors 162 and 164, as well as time measurement outputs (time count values) of each of timers 202, 204 and 206 are applied to sub CPU 200. Based on the input sensing outputs of paper passage detection sensors 162 and 164 and time measurement outputs of timers 202, 204 and 206, sub CPU 200 controls driving of motors 150, 156, 158 and 160 and controls on/off of paper feed clutch 152 and conveying clutch 154.

It is noted that, in the present embodiment, paper conveying unit 70 and controller 170 function as the paper conveying device of the present invention.

[Software Configuration]

The present image forming apparatus 100 is programmed such that when a plurality of sheets of paper P are successively fed to the paper conveying path S and a preceding sheet of paper is temporarily stopped at registration roller pair 130, a succeeding, following sheet of paper is temporarily stopped at a prescribed position G downstream of conveyer roller pair 140 in the paper conveying direction, and when the succeeding sheet is to be re-conveyed at a prescribed timing, the timing to start re-conveyance is changed in accordance with the length of the paper (the length of the sheet of paper in the paper conveying direction).

The program used is stored in RAM 176 or HDD 178 of controller 170 and realizes various functions of image forming apparatus 100 as will be described in the following. These functions are realized by main CPU 172 in the above-described controller 170, which is effectively a computer, and sub CPU 200 in paper conveying unit 70 executing the program mentioned above. The program is activated when start key 192 for starting copy-printing is pressed, or when a print instruction is received from an external device.

Referring to FIG. 10, the program includes: a step S1000 of receiving the information related to paper size; a step S1006, executed after step S1000, of selecting a paper feed tray containing the paper of received paper size; a step 1010, executed after step S1006, of feeding the first sheet of paper from the selected paper feed tray to the paper conveying path S; a step S1020, executed after step S1010, of feeding the next sheet to the paper conveying path S; a step S1030, executed after step S1020, of temporarily stopping the preceding sheet (preceding sheet) at registration roller pair 130; a step S1040, executed after step S1030, of temporarily stopping the succeeding sheet at a prescribed position G downstream of conveyer roller pair 140 in the paper conveying direction, while the preceding sheet of paper is stopped at registration roller pair 130; a step S1050, executed after step S1040, of starting re-conveyance of the sheet by registration roller pair 130; and a step S1060, executed after step S1050, of determining whether or not the paper length of the sheet of paper stopped at the position G is shorter than the distance (path length) from the nip portion between paper feed roller 66 and separation roller 68 to the temporary stop position G, and branching the flow of control depending on the result of determination.

Selection of paper feed tray at step S1006 takes place even when there is only one paper feed tray.

The program further includes: a step S1070, executed if it is determined at step S1060 that the paper length of the sheet is shorter than the path length, of delaying the timing to start re-conveyance by a prescribed time period and starting re-conveyance of the succeeding sheet of paper, a step S1080, executed if it is determined at step S1060 that the paper length is not shorter than the path length, of starting re-conveyance of the succeeding sheet of paper at a prescribed timing (normal timing to start re-conveyance); and a step S1090, executed after step S1070 or S1080, of determining whether all prints are completed, and branching the flow of control depending on the result of determination. If it is determined at step S1090 that all prints are completed, the program ends. If it is determined that not all prints are completed yet, the control returns to step S1020.

[Operation]

Referring to FIGS. 10 and 11, the operation of image forming apparatus 100 in accordance with the present embodiment, based on the above-described structure and the flowchart, will be described in the following. In the following, an example will be given in which sheets of paper contained in paper feed tray 62 are successively fed to paper conveying path S and printed. Further, in the following, the operation from feeding a sheet to paper conveying path S until the sheet is re-conveyed from registration roller pair 130 to image forming unit 30 will be described. General operations related to image formation are unrelated to the essential concept of the present invention and, therefore, description thereof will not be given here.

When start key 192 to start copying is pressed, or a print instruction is received from an external device, controller 170 receives the information related to the paper size (step S1000 shown in FIG. 10). Specifically, it receives an instruction related to which size of paper is to be used for printing. Receiving the information related to the paper size, image forming apparatus 100 selects the paper feed tray containing the paper of the received paper size, by looking-up the information related to the paper size stored in RAM 176 (step S1006).

When the paper feed tray is selected, the sheets of paper P in the selected paper feed tray 62 are successively fed one by one to the paper conveying path S. When the first sheet of paper is fed to the paper conveying path S (step S1010), the second sheet of paper is successively fed to the paper conveying path S (step S1020). The fed first sheet of paper is conveyed by the conveying system to the registration roller pair 130. When the first sheet reaches the registration roller pair 130, the first sheet of paper abuts the nip portion of registration roller pair 130 (step S1030). The sheet abutting the registration roller pair 130 warps and hence, skew is corrected.

Referring to the time chart of FIG. 11, paper feeding/conveying operation will be described in greater detail. Referring to FIG. 11, the numerical values on the ordinate on the side of "conveying motor" and "registration roller motor" represent paper feed speed (mm/sec).

When paper feed motor 150 and paper feed clutch 152 are turned on, pick-up roller 64, paper feed roller 66 and separation roller 68 rotate, and by the rotations of these rollers 64, 66 and 68, a sheet in paper feed tray 62 is fed to paper conveying path S. The fed paper is conveyed by the conveyer rollers at a feed speed of, for example, 500 mm/sec. When the conveyed sheet of paper turns off the first paper passage detection

sensor **162**, using this as a trigger, the first timer **202** starts time measurement and, after a time period T**1**, registration roller motor **160** stops. At timing E**1**, after a time period T**2** from turning off of the first paper passage detection sensor **162** (first paper sensor), registration roller pair **130** is fully stopped. A prescribed time period after turning off of the first paper passage detection sensor **162**, the conveying motor is turned off. At time E**2**, after timing E**1** when the registration roller pair **130** is fully stopped, the sheet reaches registration roller pair **130**. The timing E**2** at which the sheet reaches registration roller pair **130** is set to be earlier than timing E**3** when the conveying motor is fully stopped. Thus, the conveyed sheet abuts registration roller pair **130**, of which rotation is stopped, and the sheets warps. Thereafter, at such a timing that the leading edge of toner image on photoreceptor drum **20** is aligned with the leading edge of paper P, the conveying motor and registration roller motor **160** are turned on, and registration roller pair **130** re-conveys the sheet between intermediate transfer belt **42** and transfer roller **56**, at a feed speed (process speed) of, for example, 330 mm/sec. The timing of re-conveyance from registration roller pair **130** is measured by the second timer **204**.

On the other hand, while the preceding sheet is stopped at registration roller pair **130**, if the following, succeeding sheet turns on the second paper passage detection sensor **164** (second paper sensor), vertical conveying clutch **154** is turned off at that that timing A**1**, and the succeeding sheet is temporarily stopped at the position G. After a prescribed time period, at timing A**2**, vertical conveying clutch **154** is turned on and the succeeding sheet is conveyed toward registration roller pair **130**.

As described above, depending on the size of conveyed paper (paper length in the direction of conveyance), the temporary stopping position may deviate from the position G. If the timing A**2** to start re-conveyance toward registration roller pair **130** is kept constant regardless of such positional deviation, conveyance variation would result.

By way of example, assume that the succeeding sheet of paper is stopped deviated to the side more downstream in the conveying direction than the temporary stop position G. If the succeeding paper is re-conveyed and carried, the interval or space from the preceding sheet at the registration roller pair **130** will be too short, and the succeeding sheet will reach registration roller pair **130** before the registration roller pair **130** stops. In that case, the arriving sheet enters the nip portion of registration roller pair **130** and, therefore, skew correction fails. In addition, the sheet is fed earlier with respect to the image to be formed, off the timing of positional alignment and, hence, the image position will be varied.

In view of the foregoing, in the present embodiment, the paper length of the conveyed sheet of paper is detected, and whether the detected paper length is shorter than the above-described path length is determined (step S**1060** shown in FIG. **10**). Specifically, while the succeeding sheet of paper is temporarily stopped, whether the sheet is pinched at the nip portion between paper feed roller **66** and separation roller **68** is detected, based on the paper length of the sheet.

If the detected paper length is shorter than the above-mentioned path length (YES at step S**1060**), the timing A**2** to start re-conveyance (see FIG. **1**) is delayed by a prescribed time period than the normal timing (the time period T**3**from the timing A**2** to start re-conveyance until the timing E**2** at which the succeeding sheet reaches registration roller pair **130** is made shorter). On the other hand, if the detected paper length is longer than the above-mentioned path length, the timing A**2** to start re-conveyance is unchanged from the normal timing. Thus, the interval between sheets of paper at registration roller pair **130** can be kept constant.

The above-described paper conveying operation is repeated until all image data is printed.

[Effects of the Present Embodiment]

As is apparent from the foregoing description, use of image forming apparatus **100** in accordance with the present embodiment attains the following effects.

While the preceding sheet of paper is stopped at registration roller pair **130**, the following, succeeding sheet of paper is temporarily stopped at prescribed position G downstream of conveyer roller pair **140** in the paper conveying direction. It follows that the succeeding sheet of paper is conveyed closer to the preceding sheet and kept in the standby state at that position. Then, at a prescribed timing the sheet is re-conveyed toward the registration roller pair **130**. Thus, the interval between the preceding and succeeding sheets of paper can easily be made shorter.

When the succeeding sheet of paper is temporarily stopped, the load of the conveying system exerted on the succeeding sheet of paper may differ depending on the paper length of the sheet (paper length of the sheet in the paper conveying direction). Therefore, positional deviation results at the temporary stop position G, in accordance with the paper length of the conveyed sheet of paper. Specifically, the load of conveying system differs depending on the paper length of the conveyed sheet of paper, causing difference in the stop position. If the timing to start re-conveyance toward registration roller pair **130** is kept constant regardless of such positional deviation, variation in conveyance would be caused.

In image forming apparatus **100** (paper conveying unit **70**) in accordance with the present embodiment, the timing to start re-conveyance of succeeding sheet of paper is changed in accordance with the paper length of the conveyed sheet of paper. Thus, the interval between the sheets at registration roller pair **130** can be kept constant. Consequently, even when CPM is increased, variation in conveyance can be reduced. Since variation in conveyance is reduced, it becomes possible to temporarily stop the conveyed sheet of paper and re-convey the sheet reliably at registration roller pair **130**. Thus, successful skew correction of the sheet of paper becomes possible, and the timing of registration can successfully be adjusted to align the reference of leading edge of the paper. This prevents degradation of print quality. As a result, the number of prints per unit time (CPM) can be increased as much as possible while not very much increasing the speed of image formation in copy-printing (process speed) (with the process speed kept as low as possible), and the productivity can be improved.

Whether or not the paper length of conveyed sheet of paper is shorter than the path length from the nip portion between paper feed roller **66** and separation roller **68** to the position G at which the succeeding sheet of paper is temporarily stopped is determined, and if the paper length of conveyed sheet of paper is determined to be shorter than the path length, the timing to start re-conveyance of succeeding sheet of paper is delayed by a prescribed time period. Thus, the interval between the sheets of paper at registration roller pair **130** can easily be kept constant. If the paper length of conveyed sheet of paper is determined to be not shorter (longer) than the path length, it follows that the succeeding sheet tends to stop easily at the temporary stop position. Therefore, positional deviation at that position is unlikely. Therefore, in this situation, the timing to start re-conveyance of succeeding sheet of paper is unchanged, and thus, the interval between the sheets of paper

at registration roller pair **130** can easily be kept constant. By the above-described configuration, variation in conveyance can easily be reduced.

The effects described above will be noticeable felt in a high-speed apparatuses capable of high-speed printing.

(Second Embodiment)

Referring to FIG. **12**, an image forming apparatus **300** in accordance with the present embodiment differs from the above-described first embodiment in that multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D capable of containing a plurality of sheets of paper are provided.

[Overall Configuration]

Image forming apparatus **300** includes, in place of paper conveying unit **70** of the first embodiment, a paper conveying unit **370**. Paper conveying unit **370** includes a conveying system for conveying sheets of paper contained in multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D. The conveying system includes four paper feed systems for feeding sheets of paper from multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D to the paper conveying path toward image forming unit **30**, and a paper conveying system for conveying the sheets of paper from each of these paper feed systems through the paper feed path to image forming unit **30**.

The first paper feed system includes, in order to feed sheets of paper contained in the upper-most, first paper feed tray **62**A one by one to the paper conveying path, a pick-up roller **64***a*, and a paper feed roller **66***a* and a separation roller **68***a* positioned as a pair of upper/lower rollers to function as a separating roller pair. By the rotation of these rollers **64***a*, **66***a* and **68***a*, the sheets of paper P stacked and contained in the first paper feed tray **62**A are picked-up one by one from the uppermost one and fed to the paper conveying path. Pick-up roller **64***a*, paper feed roller **66***a* and separation roller **68***a* are arranged at a paper discharging end of the first paper feed tray **62**A. The sheet of paper P fed from the first paper feed tray **62**A to the paper conveying system by the operation of these rollers **64***a*. **66***a* and **68***a* is conveyed by the conveying system to registration roller pair **130** provided along the paper conveying path.

The second paper feed system includes, in order to feed sheets of paper contained in the middle, second paper feed tray **62**B one by one to the paper conveying path, a pick-up roller **64***b*, and a paper feed roller **66***b* and a separation roller **68***b* positioned as a pair of upper/lower rollers to function as a separating roller pair. By the rotation of these rollers **64***b*, **66***b* and **68***b*, the sheets of paper P stacked and contained in the second paper feed tray **62**B are picked-up one by one from the uppermost one and fed to the paper conveying path. Pick-up roller **64***b*, paper feed roller **66***b* and separation roller **68***b* are arranged at a paper discharging end of the second paper feed tray **62**B. The sheet of paper P fed from the second paper feed tray **62**B to the paper conveying system by the operation of these rollers **64***b*, **66***b* and **68***b* is conveyed by the conveying system to registration roller pair **130** provided along the paper conveying path.

The third paper feed system includes, in order to feed sheets of paper contained in the lowermost, third paper feed tray **62**C one by one to the paper conveying path, a pick-up roller **64***c*, and a paper feed roller **66***c* and a separation roller **68***c* positioned as a pair of upper/lower rollers to function as a separating roller pair. By the rotation of these rollers **64***c*. **66***c* and **68***c*, the sheets of paper P stacked and contained in the third paper feed tray **62**C are picked-up one by one from the uppermost one and fed to the paper conveying path. Pick-up roller **64***c*, paper feed roller **66***c* and separation roller **68***c* are arranged at a paper discharging end of the third paper feed tray **62**C. The sheet of paper P fed from the third paper feed tray **62**C to the paper conveying system by the operation of these rollers **64***c*, **66***c* and **68***c* is conveyed by the conveying system to registration roller pair **130** provided along the paper conveying path.

The fourth paper feed system includes, in order to feed sheets of paper contained in the fourth paper feed tray **62**D, provided parallel to the uppermost, first paper feed tray **62**A, one by one to the paper conveying path, a pick-up roller **64***d*, and a paper feed roller **66***d* and a separation roller **68***d* positioned as a pair of upper/lower rollers to function as a separating roller pair. By the rotation of these rollers **64***d*, **66***d* and **68***d*, the sheets of paper P stacked and contained in the fourth paper feed tray **62**D are picked-up one by one from the uppermost one and fed to the paper conveying path. Pick-up roller **64***d*, paper feed roller **66***d* and separation roller **68***d* are arranged at a paper discharging end of the fourth paper feed tray **62**D. The sheet of paper P fed from the fourth paper feed tray **62**D to the paper conveying system by the operation of these rollers **64***d*, **66***d* and **68***d* is conveyed by the conveying system to registration roller pair **130** provided along the paper conveying path.

Paper conveying unit **370** further includes conveyer rollers **140**, **142**, **144**, **340** to **352** for conveying sheets of paper fed from multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D. Conveyer rollers **340** to **352** and the first to fourth paper feed systems are driven by paper feed motor **310** as a driving source. In the first paper feed system, the driving force of paper feed motor **310** is transmitted by a paper feed clutch **152**A. In the second paper feed system, the driving force of paper feed motor **310** is transmitted by a paper feed clutch **152**B. In the third paper feed system, the driving force of paper feed motor **310** is transmitted by a paper feed clutch **152**C. In the fourth paper feed system, the driving force of paper feed motor **310** is transmitted by a paper feed clutch **152**D.

The sheet of paper fed from the first paper feed tray **62**A is conveyed, by way of example, by three pairs of conveyer rollers **140**, **142** and **144**. The sheet of paper fed from the second paper feed tray **62**B is conveyed, by way of example, by six pairs of conveyer rollers **344**, **342**, **340**, **140**, **142** and **144**. The sheet of paper fed from the third paper feed tray **62**C is conveyed, by way of example, by seven pairs of conveyer rollers **348**, **346**, **342**, **340**, **140**, **142** and **144**. The sheet of paper fed from the fourth paper feed tray **62**D is conveyed, by way of example, by four pairs of conveyer rollers **352**, **350**, **142** and **144**.

To conveyer roller pairs **140** and **340**, the driving force of paper feed motor **310** is transmitted by a vertical conveying clutch **154**A. To conveyer roller pairs **342**, **344**, **346** and **348**, the driving force of paper feed motor **310** is transmitted by a vertical conveying clutch **154**B. To conveyer roller pairs **350** and **352**, the driving force of paper feed motor **310** is transmitted by a relaying conveying clutch **154**C.

Each of these clutches is an electromagnetic or electric clutch, and when the clutch is turned on, the driving force of paper feed motor **310** is transmitted and when the clutch is turned off, transmission of the driving force of paper feed motor **310** is stopped.

In the vicinity of conveyer roller pair **140**, at a position upstream of registration roller pair **130**, a second paper passage detection sensor **164** is provided. A sheet of paper fed from any of the first, second, and third paper feed trays **62**A, **62**B and **62**C has its state of conveyance detected by the second paper passage detection sensor **164**, and the conveyed sheet of paper is temporarily stopped at the timing of detection. Specifically, when the second paper passage detection sensor **164** detects the leading edge of succeeding (following)

sheet of paper, the sheet of paper is temporarily stopped at the timing of detection. Thus, the succeeding sheet of paper temporarily stops at a prescribed position G1 downstream of conveyer roller pair **140** in the paper conveying direction. Thereafter, the succeeding sheet of paper is re-conveyed toward registration roller pair **130** at a prescribed timing.

In the vicinity of conveyer roller **350**, at a position upstream of registration roller pair **130**, a third paper passage detection sensor **320** is provided. A sheet of paper fed from the fourth paper feed tray **62**D has its state of conveyance detected by the third paper passage detection sensor **320**, and the conveyed sheet of paper is temporarily stopped at a prescribed time period after the detection of the leading edge of the sheet. Specifically, when the third paper passage detection sensor **320** detects the leading edge of succeeding (succeeding) sheet of paper, the sheet of paper is temporarily stopped at the timing a prescribed time period after the detection. Thus, the succeeding sheet of paper temporarily stops at a prescribed position G2 downstream of conveyer roller **350** in the paper conveying direction. Thereafter, the succeeding sheet of paper is re-conveyed toward registration roller pair **130** at a prescribed timing.

Therefore, as to the sheets fed from the first, second and third paper feed trays **62**A. **62**B and **62**C, the position where the sheet is temporarily stopped while the preceding sheet of paper is temporarily stopped at registration roller pair **130** is the position G1. On the other hand, as to the sheet of paper fed from the fourth paper feed tray **62**D, the position where the sheet is temporarily stopped while the preceding sheet of paper is temporarily stopped at registration roller pair **130** is the position G2.

As described above, in the present embodiment, the distance (path length) from the nip portion between the paper feed roller and the separation roller to the position where the sheet is temporarily stopped differs tray by tray. The path length for each tray is stored in a storage unit such as ROM **174**, RAM **176** or HDD **178**, in association with the paper feed tray. Thus, when a desired paper feed tray is selected to select desired sheets of paper, the path length corresponding to the selected paper feed tray is detected.

In the present embodiment, as in the first embodiment described above, information related to the paper size of sheets of paper contained in respective paper feed trays **62**A, **62**B, **62**C and **62**D is stored in RAM **176** in association with respective paper feed trays. When the information related to the paper size of a document of which image information is to be read by scanner unit **92** is received, or when a command related to the paper size included in the image data transmitted from an external device such as client PC **600** is received, image forming apparatus **300** selects a paper feed tray containing the sheets of paper of the paper size corresponding to the received information related to the paper size, from among the plurality of paper feed trays, by looking up the information related to the paper size stored in RAM **176**. When any of the paper feed trays is selected, the above-described path length corresponding to the selected paper feed tray is detected.

Selection of paper is also possible by an operation of paper selection screen image **380** displayed on operation unit **190** (display panel **194**) of image forming apparatus **300**. Referring to FIG. **13**, on paper selection screen image **380**, selection keys **382** to **388** allowing selection of multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D are displayed. For example, if selection key **382** is operated, the first paper feed tray **62**A is selected; if selection key **384** is operated, the second paper feed tray **62**B is selected; if selection key **386** is operated, the third paper feed tray **62**C is selected; and if selection key **388** is operated, the fourth paper feed tray **62**D is selected. If any of the multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D is selected by an operation of paper selection screen image **380**, the above-described path length corresponding to the selected paper feed tray is also detected.

If printing is to be executed in accordance with a print instruction from an external device, the configuration allows selection of any of the multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D on a screen image of a user interface of a printer driver displayed on a display device (not shown) of the external device. Here, the path length and the paper size (paper length in the paper conveying direction) corresponding to the selected paper feed tray are detected from the image data transmitted from the external device.

In the present embodiment, the paper length of conveyed sheet of paper, and the path length from the nip portion between the paper feed roller and the separation roller to the position where the sheet is temporarily stopped are detected, and based on the paper length and the path length, the timing to start re-conveyance of the succeeding sheet of paper is changed.

[Software Configuration]

Referring to FIG. **14**, in image forming apparatus **300** in accordance with the present embodiment, the process steps except for step S**2000** are the same as those executed by the computer program shown in FIG. **10**. In the following, the difference will be described.

The program includes a step S**2000**, executed after step S**1006**, of detecting a distance (path length) from the nip portion between the paper feed roller and the separation roller to the position where the sheet is temporarily stopped. At step S**2000**, in accordance with the selected paper feed tray, the path length for the paper feed tray is detected. When the process of step S**2000** is done, the control proceeds to step S**1010**.

[Operation]

Referring to FIGS. **12** to **14**, the operation of image forming apparatus **300** in accordance with the present embodiment, based on the above-described structure and the flowchart, will be described in the following. It is noted that the operations except for the operation of detecting the path length are the same as those of the first embodiment described above. Therefore, detailed description of the same operations will not be repeated.

When start key **192** to start copying is pressed, or a print instruction is received from an external device, controller **170** receives the information related to the paper size (step S**1000** shown in FIG. **14**). Specifically, it receives an instruction related to which size of paper is to be used for printing. Receiving the information related to the paper size, image forming apparatus **100** selects the paper feed tray containing the paper of the received paper size, by looking-up the information related to the paper size stored in RAM **176**, from multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D (step S**1006**). When the paper feed tray is selected, the above-described path length corresponding to the selected paper feed tray is detected (step S**2000**).

If the paper (paper feed tray) is to be selected by the operation of paper selection screen image **380**, the user first causes operation unit **190** to display paper selection screen image **380** (see FIG. **13**). The user can designate a desired paper feed tray by operating the paper selection screen image **380**. On respective selection keys **382** to **388** on paper selection screen image **380**, the paper size and orientation of sheets of paper contained in paper feed trays **62**A, **62**B, **62**C and **62**D are displayed. By operating any of selection keys **382** to **388**, the paper feed tray containing sheets of paper of the desired

size is selected. The sheets of paper contained in the selected paper feed tray are designated as the paper for printing.

When start key **192** to start copying is pressed, or a print instruction is received from an external device, the information related to the paper size is received (step S**1000**). Here, the paper size of the designated sheets of paper mentioned above is received as the information related to the paper size. Since the sheets of paper of the received paper size are contained in the designated paper feed tray, the designated paper feed tray is selected from multi-stage paper feed trays **62**A. **62**B, **62**C and **62**D (step S**1006**). When the paper feed tray is selected, the path length corresponding to the selected paper feed tray is detected (step S**2000**).

If printing is to be executed in accordance with a print instruction from an external device, it is possible to select any of the multi-stage paper feed trays **62**A. **62**B, **62**C and **62**D on a screen image of a user interface of a printer driver displayed on a display device of the external device. Here, the paper length and the path length are detected from the image data (print data) transmitted from the external device.

Thereafter, the paper conveying operation similar to that of the first embodiment is executed.

[Effects of the Present Embodiment]

As is apparent from the description above, use of image forming apparatus **300** in accordance with the present embodiment attains the following effects.

Based on the path length from the nip portion between the paper feed roller and the separation roller to the position where the sheet is temporarily stopped and on the paper length of the conveyed sheet of paper, the timing to start re-conveyance of the succeeding sheet of paper is changed and, therefore, even when the path length is different, variation in conveyance can be reduced.

For any sheet of paper fed from the plurality of paper feed trays to the paper conveying path, the sheet is stopped at the timing when the second paper passage detection sensor **164** detects the leading edge of the sheet. Thus, any sheet of paper fed from the plurality of paper feed trays to the paper conveying path is stopped temporarily at the prescribed position G**1** downstream of conveyer roller pair **140** in the paper conveying direction. Thus, any sheet of paper fed from the plurality of paper feed trays to the paper conveying path comes to be temporarily stopped at the same position. Thus, when the timing to start re-conveyance of the succeeding sheet of paper is to be changed in accordance with the paper length of conveyed sheet of paper, the timing to start re-conveyance can be changed easily. In additions, any sheet of paper fed from the plurality of paper feed trays to the paper conveying path can be conveyed closer to the preceding paper and kept standby at that position.

Other effects are the same as those of the first embodiment.

(Third Embodiment)

In the present embodiment, different from the first and second embodiments described above, the amount of positional deviation of a succeeding sheet of paper at the temporary stopping position is measured and, in accordance with the measured amount of deviation, the timing to start re-conveyance of the succeeding sheet of paper is changed.

The image forming apparatus in accordance with the present embodiment has the same hardware configuration as that of the image forming apparatus **300** in accordance with the second embodiment. The program and the like stored in RAM **176** or HDD **178** of controller **170** are different.

Referring to FIG. **12**, the method of measuring the amount of deviation of succeeding sheet of paper will be described. In the following, an example will be given in which sheets of paper are fed from any of the first, second and third paper feed trays **62**A. **62**B and **62**C and the succeeding sheet of paper is temporarily stopped at position G**1**.

When a fed sheet of paper turns off the second paper passage detection sensor **164**, conveyance of the sheet of paper is stopped at this timing, and the sheet is temporarily stopped at position G**1**. When the sheet is re-conveyed at a prescribed timing and the trailing edge of the sheet passes over the second paper passage detection sensor **164**, the second paper passage detection sensor **164** turns on. At that timing, a timer, not shown, starts measurement. When the leading edge of the conveyed sheet of paper reaches the first paper passage detection sensor **162**, the first paper passage detection sensor turns off. At this timing, measurement by the timer is stopped.

In a storage unit such as RAM **176** or HDD **178**, a reference time (required time when there is no positional deviation) from the turning on of second paper passage detection sensor **164** to the turning off of first paper passage detection sensor **162** for each paper size (for each paper length in the paper conveying direction) is stored.

If there is any positional deviation at the position G**1**, the time from turning on of second paper passage detection sensor **164** to the turning off of first paper passage detection sensor **162** becomes different from the reference time. By way of example, if there is a downstream side positional deviation of sheet in the paper conveying direction at position G**1**, the time from turning on of second paper passage detection sensor **164** to the turning off of first paper passage detection sensor **162** becomes shorter than the reference time. Therefore, by comparing the time from turning on of second paper passage detection sensor **164** to the turning off of first paper passage detection sensor **162** with the reference time, the amount of deviation can be measured.

The amount of deviation can also be measured in the similar manner as described above when sheets of paper are fed from the fourth paper feed tray **62**D and the succeeding sheet of paper is temporarily stopped at position G**2**.

[Software Configuration]

Referring to FIG. **15**, in the image forming apparatus in accordance with the present embodiment, the process steps except for steps S**3000**, S**3010**, S**3020**, S**3030** and S**3040** are the same as those executed by the computer program shown in FIG. **10**. In the following, the difference will be described.

The program includes: a step S**3000**, executed after step S**1020**, of measuring amount of positional deviation of the succeeding sheet of paper and causing the control flow to proceed to step S**1030**; a step S**3010**, executed after step S**1050**, of determining whether or not there is any positional deviation caused, based on the result of measurement of positional deviation at step S**3000**, and branching the flow of control depending on the result of determination; a step S**3020**, executed if it is determined at step S**3010** that there is a positional deviation, of calculating the timing to start re-conveyance in consideration of the amount of deviation; a step S**3030**, executed after step S**3020**, of starting re-conveyance of the succeeding sheet of paper at the calculated timing to start re-conveyance; and a step S**3040**, executed if it is determined at step S**3010** that there is no positional deviation, of starting re-conveyance of the succeeding sheet of paper at the prescribed timing (normal timing to start re-conveyance). When the process at step S**3030** or S**3040** ends, the control proceeds to step S**1090**.

FIG. **16** is a detailed flowchart of step S**3000** shown in FIG. **15**. With reference to FIG. **16**, the flow of the process for measuring amount of deviation when sheets of paper are fed from any of the first, second and third paper feed trays **62**A, **62**B and **62**C will be described.

Referring to FIG. **16**, the routine includes: a step **3500** of determining whether or not the second paper passage detection sensor **164** is turned from on to off, and waiting until the second paper passage detection sensor **164** is turned off; a step S**3510**, executed if it is determined at step S**3500** that the second paper passage detection sensor **164** is turned off, of turning on the timer and starting measurement at the timing of turning off; a step S**3520**, executed after step S**3510**, of determining whether the first paper passage detection sensor **162** is turned from off to on, and waiting until the first paper passage detection sensor **162** is turned on; a step S**3530**, executed if it is determined at step S**3520** that the first paper passage detection sensor **162** is turned on, of turning off the timer to stop measurement at the timing of turning on; and a step S**3540**, executed after step S**3530**, of calculating the amount of deviation from the conveyance time of paper measured by the timer, and ending the routine.

The flow of measuring the amount of deviation when the sheets of paper are fed from the fourth paper feed tray **62**D is the same as above.

[Operation]

Referring to FIG. **15**, the operation of image forming apparatus in accordance with the present embodiment, based on the above-described structure and the flowchart, will be described in the following.

When start key **192** to start copying is pressed, or a print instruction is received from an external device, controller **170** receives the information related to the paper size (step S**1000** shown in FIG. **15**). Receiving the information related to the paper size, image forming apparatus **100** selects the paper feed tray containing the paper of the received paper size, by looking-up the information related to the paper size stored in RAM **176**, from multi-stage paper feed trays **62**A. **62**B, **62**C and **62**D (step S**1006**).

When the paper feed tray is selected, the sheets of paper in the selected paper feed tray are successively fed one by one to the paper conveying path. When the first sheet of paper is fed to the paper conveying path S (step S**1010**), the second sheet of paper is successively fed to the paper conveying path (step S**1020**). The fed first sheet of paper is conveyed by the conveying system to the registration roller pair **130**. When the first sheet reaches the registration roller pair **130**, the first sheet of paper abuts the nip portion of registration roller pair **130** (step S**1030**). The sheet abutting the registration roller pair **130** warps and hence, skew is corrected.

In the meanwhile, the amount of positional deviation at the temporary stop position is measured (step S**3000**). If there is any positional deviation of sheet (YES at step S**3010**), the timing to start re-conveyance is calculated in consideration of the amount of deviation, and re-conveyance of the succeeding sheet of paper is started at the calculated timing to start re-conveyance. Specifically, the timing to start re-conveyance is changed from the normal timing. On the other hand, if there is no positional deviation of sheet (NO at step S**3010**), re-conveyance of the succeeding sheet is started at the prescribed timing. Specifically, if there is no positional deviation of sheet, the timing to start re-conveyance is unchanged from the normal timing. Thus, the interval between the sheets can be kept constant at the registration roller pair **130**.

[Effects of the Present Embodiment]

As is apparent from the foregoing description, use of image forming apparatus in accordance with the present embodiment attains the following effects.

Since the timing to start re-conveyance of the succeeding sheet of paper is changed in accordance with the measured amount of deviation, re-conveyance of the succeeding sheet of paper can be started at the timing of re-conveyance in accordance with the amount of deviation. Therefore, the interval between the sheets at the registration roller pair **130** can more easily be kept constant. Thus, it becomes easier to reduce variation in conveyance.

[Fourth Embodiment]

Referring to FIG. **17**, an image forming apparatus **500** in accordance with the present embodiment further includes, in addition to the image forming apparatus **300** in accordance with the second embodiment, paper sensors **510**, **520**, **530** and **540** for detecting whether a sheet is pinched between the paper feed roller and the separation roller. Specifically, paper sensors **510**, **520**, **530** and **540** are provided in the vicinity of each of the paper feed systems (near the nip portion between the paper feed roller and the separation roller) of multi-stage paper feed trays **62**A, **62**B, **62**C and **62**D, respectively.

Each of the paper sensors **510** to **540** detects, when the succeeding sheet of paper is temporarily stopped at the prescribed position, whether the sheet is pinched between the paper feed roller and the separation roller. If the succeeding sheet of paper is pinched at the nip portion between the paper feed roller and the separation roller, it is considered that there is hardly any positional deviation from the temporary stop position. Therefore, the succeeding sheet of paper is re-conveyed at the prescribed timing (normal timing to start re-conveyance). On the other hand, if the succeeding sheet is not pinched at the nip portion between the paper feed roller and the separation roller, it is considered that there is a positional deviation at the temporary stop position. Therefore, the timing to start re-conveyance is delayed by a prescribed time period from the normal timing to start re-conveyance. Here, the amount of deviation is substantially constant as in the first embodiment described above, and it can be detected by measurement in advance.

[Software Configuration]

Referring to FIG. **18**, in image forming apparatus **500** in accordance with the present embodiment, process steps other than step S**4000** are the same as those executed by the computer program shown in FIG. **10**. In the present embodiment, step S**4000** mentioned above is included in place of step S**1060** of FIG. **10**. In the following, the difference will be described.

The program includes step S**4000**, executed after step S**1050**, of determining whether or not the sheet is pinched at the nip portion between the paper feed roller and the separation roller, and branching the flow of control depending on the result of determination. If it is determined at step S**4000** that the sheet is pinched at the nip portion between the paper feed roller and the separation roller, the control proceeds to step S**1070**, and if it is determined that the sheet is not pinched at the nip portion between the paper feed roller and the separation roller, the control proceeds to step S**1080**.

[Operation]

The operation of image forming apparatus **500** in accordance with the present embodiment, based on the above-described structure and the flowchart, will be described in the following. It is noted that operations other than the operation of determining whether or not a sheet is pinched at the nip portion between the paper feed roller and the separation roller are the same as those of the first and second embodiments described above. Therefore, detailed description of similar operations will not be repeated. In the following, the operation of image forming apparatus **500** when sheets of paper are fed from the second paper feed tray **62**B will be described as an example.

When the preceding sheet of paper is stopped at registration roller pair **130**, the following, succeeding sheet of paper is temporarily stopped at a prescribed position. The succeed-

ing sheet of paper is conveyed closer to the preceding sheet, and kept standby at that position. Paper sensor **520** of the second paper feed tray **62**B detects whether or not the succeeding sheet of paper, which is temporarily stopped, is pinched at the nip portion between paper feed roller **66***b* and separation roller **68***b*, and transmits a detection signal to main CPU **172** of controller **170** or to sub CPU **200**.

Based on the signal from paper sensor **520**, controller **170** determines whether the succeeding sheet of paper is pinched at the nip portion between paper feed roller **66***b* and separation roller **68***b*, and depending on the result of determination, changes the timing to start re-conveyance of the succeeding sheet of paper.

[Effects of the Present Embodiment]

As is apparent from the foregoing description, use of image forming apparatus **500** in accordance with the present embodiment attains the following effects.

Whether or not the sheet is pinched at the nip portion between the paper feed roller and the separation roller is detected by paper sensors **510** to **540**, and whether there is a positional deviation of the succeeding sheet at the temporary stop position is determined thereby. Since the timing to start re-conveyance of the succeeding sheet is changed in accordance with the result of determination, effects similar to those of the first and second embodiments can be attained.

[Modifications]

Though the present invention is applied to an MFP as an example of image forming apparatuses in the embodiments above, the present invention is not limited to such embodiments. For example, the image forming apparatus may be a copy machine or a printer.

Though an example in which the paper conveying unit includes a sub CPU has been described in the embodiments above, the present invention is not limited to such embodiments. For example, a configuration in which the paper conveying unit is not provided with the sub CPU is also possible. Specifically, paper conveying unit may be controlled only by the main CPU. If the paper conveying unit includes a sub CPU, part of the paper conveying unit may be controlled by the main CPU. Further, the registration roller motor may be connected not to the sub CPU but to the main CPU.

In the embodiment above, the paper feed tray may be a mixed-loading type paper feed tray. When multi-stage paper feed trays are used, all or some of the paper feed trays may be of the mixed-loading type.

Though an example in which the paper size is unchanged during printing has been described in the embodiments above, the present invention is not limited to such embodiments. For example, printing may be done with the paper size changed during printing. In that case, the information related to the paper size (paper length in the conveying direction) and the path length (the distance from the nip portion between the paper feed roller and the separation roller to the temporary stop position) may be received at the timing when the paper size is changed.

Though an example in which the paper size of sheets of paper stacked and contained in the paper feed tray is detected, for example, by a sensor unit provided in the paper feed tray has been described in the embodiments above, the present invention is not limited to such embodiments. The paper size of paper to be conveyed may be detected by any method other than the one described in the embodiments above. Further, in the embodiments above, the sensor unit need not be provided in the paper feed tray. By way of example, it the paper size of contained sheets of paper is determined tray by tray and the paper size is set in advance, the paper size of sheets stacked and contained may be detected without providing any sensor unit. Further, the paper size of sheets of paper stacked and contained in each paper feed tray may be set by operation unit **190** (display panel **194**). In other words, the paper size of sheets of paper stacked and contained in paper feed tray may be input by the user. In that case, the paper size input through operation unit **190** is stored in a memory such as an RAM, in association with the paper feed tray.

Though an example in which the information related to the paper size is stored in the RAM has been described in the embodiments above, the present invention is not limited to such embodiments. The memory storing the information related to the paper size may be any memory other than the RAM.

Though an example in which the paper conveyance program is transmitted from another device to the controller through the LAN line and the NIC and stored in the ROM or HDD has been described in the embodiments above, the present invention is not limited to such embodiments. By way of example, a disk drive such as a DVD drive. CD-ROM drive or FD drive, a memory port or the like may be provided in place of NIC, and the paper conveyance program recorded on an external storage medium may be introduced to the image forming apparatus therethrough.

In the second to fourth embodiments above, an example in which any sheet of paper fed from the first, second and third paper feed trays is stopped at a timing when the leading edge of the sheet is detected by the second paper passage detection sensor has been described. The present invention, however, is not limited to such embodiments. By way of example, any sheet of paper fed from a plurality of paper feed trays to the paper conveying path may be stopped a prescribed time period after the leading edge of the sheet is detected by the paper passage detection sensor.

In the second to fourth embodiments above, an example in which for any sheet of paper fed from the first, second and third paper feed trays, the temporary stop position is the same has been described. The present invention, however, is not limited to such embodiments. By way of example, for the sheet of paper fed from a plurality of paper feed trays to the paper conveying path, the temporary stop position may be made different. It is noted, however, that by temporarily stopping at the same position, the effects of the embodiments above can be attained. Therefore, the temporary stopping position should preferably be the same for any of the sheets fed from the plurality of paper feed trays to the paper conveying path.

In the third and fourth embodiments above, an example of an image forming apparatus having multi-stage paper feed trays has been described. The present invention, however, is not limited to such embodiments. The image forming apparatus of the third and fourth embodiments may be an image forming apparatus having one stage of paper feed tray as in the first embodiment.

In the embodiments above, the number of stages of the paper feed tray can appropriately be changed. Further, in the embodiments above, the image forming apparatus may be provided with an automatic paper feed cassette capable of containing a large amount of paper of different types.

Any embodiment that can be attained by appropriately combining the techniques described above is encompassed by the scope of the present invention. By way of example, the second and third embodiments may be combined. In such a combination, even if the amount of deviation detected in advance by measurement (amount of deviation at the temporary stop position of the succeeding sheet) should be changed, the succeeding sheet can be re-conveyed at timing in accordance with the changed amount of deviation.

The embodiments as have been described here are mere examples and should not be interpreted as restrictive. The scope of the present invention is determined by each of the claims with appropriate consideration of the written description of the embodiments and embraces modifications within the meaning of, and equivalent to, the languages in the claims.

INDUSTRIAL APPLICABILITY

By the present invention, a paper conveying device capable of conveying sheets of paper without lowering print quality and increasing the number of prints per unit time, an image forming apparatus provided with the device, and a method of conveying sheets of paper can be provided.

REFERENCE SIGNS LIST

20 photoreceptor drum
22 charger
30 image forming unit
62, **62**A~**62**D paper feed tray
70, **370** paper conveying unit
92 scanner unit
100, **300**, **500** image forming apparatus
130 registration roller pair
140, **142**, **144** conveyer roller
162 first paper passage detection sensor
164 second paper passage detection sensor
170 controller
190 operation unit
192 start key
194 display panel
320 third paper passage detection sensor

The invention claimed is:

1. A paper conveying device, comprising:
a paper feeding section for feeding a sheet of paper to a paper conveying path;
a registration section, provided along said paper conveying path, for temporarily stopping the conveyed sheet of paper and re-conveying the sheet of paper;
a conveying section, provided in said paper conveying path from said paper feeding section to said registration section, for conveying the sheet of paper fed to said paper conveying path to said registration section;
a controller configured to:
receive information related to a size of the conveyed sheet of paper;
control conveyance of the sheet of paper such that when a plurality of sheets of paper are fed successively to said paper conveying path and a preceding sheet of paper is stopped at said registration section, a following, succeeding sheet of paper is temporarily stopped at a prescribed position downstream of said conveying section in the paper conveying direction, and then the sheet is re-conveyed toward said registration section at a prescribed timing;
change a timing to start re-conveyance of the succeeding sheet of paper in accordance with paper length in the paper conveying direction of the conveyed sheet of paper received by said controller; and
change the timing to start re-conveyance of the succeeding sheet of paper based on a path length from said paper feeding section to the position at which the succeeding sheet of paper is temporarily stopped and on said paper length of the conveyed sheet of paper.

2. The paper conveying device according to claim **1**, further comprising:
a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper;
wherein the controller is further configured
to temporarily stop the succeeding sheet of paper at the prescribed position downstream of said conveying section in the paper conveying direction, at a timing when said controller detects a leading edge of the sheet.

3. The paper conveying device according to claim **1**, further comprising:
a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; wherein the controller is further configured
to temporarily stop the succeeding sheet of paper at the prescribed position downstream of said conveying section in the paper conveying direction, a prescribed time period after said controller detects a leading edge of the sheet.

4. The paper conveying device according to claim **1**, further comprising:
a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; and
a plurality of paper containing sections for containing sheets of paper to be fed to said paper conveying path; wherein
wherein said controller is further configured to temporarily stop any sheet of paper fed from said plurality of paper containing section to said paper conveying path, at the prescribed position downstream of said conveying section in the paper conveying direction, at a timing when said controller detects a leading edge of the sheet.

5. The paper conveying device according to claim **1**, further comprising:
a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; and
a plurality of paper containing sections for containing sheets of paper to be fed to said paper conveying path; wherein
the controller is further configured to temporarily stop any sheet of paper fed from said plurality of paper containing section to said paper conveying path, at the prescribed position downstream of said conveying section in the paper conveying direction, a prescribed time period after said controller detects a leading edge of the sheet.

6. An image forming apparatus, comprising:
an image forming section for forming an image; and
the paper conveying device according to claim **1**, for conveying sheets of paper to said image forming section.

7. A paper conveying device, comprising:
a paper feeding section for feeding a sheet of paper to a paper conveying path;
a registration section, provided along said paper conveying path, for temporarily stopping the conveyed sheet of paper and re-conveying the sheet of paper;
a conveying section, provided in said paper conveying path from said paper feeding section to said registration section, for conveying the sheet of paper fed to said paper conveying path to said registration section;

a controller configured to

receive information related to a size of the conveyed sheet of paper; and

control conveyance of the sheet of paper such that when a plurality of sheets of paper are fed successively to said paper conveying path and a preceding sheet of paper is stopped at said registration section, a following, succeeding sheet of paper is temporarily stopped at a prescribed position downstream of said conveying section in the paper conveying direction, and then the sheet is re-conveyed toward said registration section at a prescribed timing; wherein

change a timing to start re-conveyance of the succeeding sheet of paper in accordance with paper length in the paper conveying direction of the conveyed sheet of paper received by said controller; and

determine whether said paper length of the conveyed sheet of paper is shorter than a path length from said paper feeding section to the position at which the succeeding sheet of paper is temporarily stopped, and change the timing to start re-conveyance of the succeeding sheet of paper depending on the result of determination.

8. The paper conveying device according to claim **7**, wherein

when said paper length of the conveyed sheet of paper is determined to be shorter than the path length from said paper feeding section to the position at which the succeeding sheet of paper is temporarily stopped, said controller is further configured to change the timing delays said timing to start re-conveyance of the succeeding sheet of paper by a prescribed time period; and

when said paper length of the conveyed sheet of paper is determined to be not shorter than the path length from said paper feeding section to the position at which the succeeding sheet of paper is temporarily stopped, said controller is further configured to change the timing does not change said timing to start re-conveyance of the succeeding sheet of paper.

9. The paper conveying device according to claim **7**, further comprising:

a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; wherein

wherein the controller is further configured to temporarily stop the succeeding sheet of paper at the prescribed position downstream of said conveying section in the paper conveying direction, at a timing when said controller detects a leading edge of the sheet.

10. The paper conveying device according to claim **7**, further comprising:

a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; wherein

said controller is further configured to temporarily stop the succeeding sheet of paper at the prescribed position downstream of said conveying section in the paper conveying direction, a prescribed time period after said controller detects a leading edge of the sheet.

11. The paper conveying device according to claim **7**, further comprising:

a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; and

a plurality of paper containing sections for containing sheets of paper to be fed to said paper conveying path;

wherein said controller is configured to temporarily stop any sheet of paper fed from said plurality of paper containing section to said paper conveying path, at the prescribed position downstream of said conveying section in the paper conveying direction, at a timing when said detects a leading edge of the sheet.

12. The paper conveying device according to claim **7**, further comprising:

a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; and

a plurality of paper containing sections for containing sheets of paper to be fed to said paper conveying path;

wherein the controller is further configured to temporarily stop any sheet of paper fed from said plurality of paper containing section to said paper conveying path, at the prescribed position downstream of said conveying section in the paper conveying direction, a prescribed time period after said controller detects a leading edge of the sheet.

13. An image forming apparatus, comprising:

an image forming section for forming an image; and

the paper conveying device according to claim **7**, for conveying sheets of paper to said image forming section.

14. A paper conveying device, comprising:

a paper feeding section for feeding a sheet of paper to a paper conveying path;

a registration section, provided along said paper conveying path, for temporarily stopping the conveyed sheet of paper and re-conveying the sheet of paper;

a conveying section, provided in said paper conveying path from said paper feeding section to said registration section, for conveying the sheet of paper fed to said paper conveying path to said registration section;

a controller configured to

receive information related to a size of the conveyed sheet of paper;

control conveyance of the sheet of paper such that when a plurality of sheets of paper are fed successively to said paper conveying path and a preceding sheet of paper is stopped at said registration section, a following, succeeding sheet of paper is temporarily stopped at a prescribed position downstream of said conveying section in the paper conveying direction, and then the sheet is re-conveyed toward said registration section at a prescribed timing;

measure amount of positional deviation generated when the succeeding sheet of paper is temporarily stopped at the prescribed position downstream of said conveying section in the paper conveying direction;

change a timing to start re-conveyance of the succeeding sheet of paper in accordance with paper length in the paper conveying direction of the conveyed sheet of paper received by said controller; and

change the timing to start re-conveyance of the succeeding sheet of paper in accordance with the amount of positional deviation measured by said controller.

15. The paper conveying device according to claim **14**, further comprising:

a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said regis-

tration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; wherein

the controller is further configured to temporarily stop the succeeding sheet of paper at the prescribed position downstream of said conveying section in the paper conveying direction, at a timing when said controller detects a leading edge of the sheet.

16. The paper conveying device according to claim **14**, further comprising:

a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; wherein

said controller is further configured to temporarily stop the succeeding sheet of paper at the prescribed position downstream of said conveying section in the paper conveying direction, a prescribed time period after said controller detects a leading edge of the sheet.

17. The paper conveying device according to claim **14**, further comprising:

a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; and

a plurality of paper containing sections for containing sheets of paper to be fed to said paper conveying path; wherein

said controller is further configured to temporarily stop any sheet of paper fed from said plurality of paper containing section to said paper conveying path, at the prescribed position downstream of said conveying section in the paper conveying direction, at a timing when said controller detects a leading edge of the sheet.

18. The paper conveying device according to claim **14**, further comprising:

a paper detection section, arranged close to said conveying section, at a prescribed position upstream of said registration section in the paper conveying direction, for detecting a state of conveyance of the sheet of paper; and

a plurality of paper containing sections for containing sheets of paper to be fed to said paper conveying path; wherein

said controller is further configured to temporarily stop any sheet of paper fed from said plurality of paper containing section to said paper conveying path, at the prescribed position downstream of said conveying section in the paper conveying direction, a prescribed time period after said controller detects a leading edge of the sheet.

19. An image forming apparatus, comprising:

an image forming section for forming an image; and

the paper conveying device according to claim **14**, for conveying sheets of paper to said image forming section.

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